DOCUMENT RESUME

ED 233 888	SE 042 796
TITLE	Hearings on Mathematics and Science Education (Part 2). Hearings Before the Committee on Education and Labor. House of Representatives, Ninety-Eighth Congress, First Session on H.R. 30 To Provide Assistance to Improve Elementary, Secondary and Postsecondary Education in Mathematics and Science, and for Other Purposes (January 26-28, 31, 1983).
INSTITUTION	Congress of the U.S., Washington, D.C. House Committee on Education and Labor.
PUB DATE	83
NOTE	570p.; For related document, see ED 228 076. Portions are marginally legible.
PUB TYPE	Legal/Legislative/Regulatory Materials (090) -- Reports - Descriptive (141)
EDRS PRICE	MF02 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Academic Achievement; *Educational Improvement; Educational Quality; Educational Trends; Elementary Secondary Education; Engineering Education; *Federal Aid; *Federal Legislation; Higher Education; *Mathematics Education; Mathematics Instruction; Mathematics Teachers; *Science Education; Science Instruction; Science Teachers; Teacher Education; *Teacher Shortage
IDENTIFIERS	Congress 98th

ABSTRACT

Presented are hearings on H.R. 30, the Emergency Mathematics and Science Education Act. This legislation addresses such issues as teacher shortages in mathematics and science education and declining student achievement in these subjects. H.R. 30 authorizes $300 million for fiscal year 1984 and an open-ended amount for fiscal year 1985 for programs to improve mathematics and science education at the elementary, secondary, and postsecondary levels. Under the elementary and secondary portion of the bill, $250 million is authorized for formula grants to state education agencies, which must pass through 95 percent of the funds to local educational agencies. These agencies can use these funds for inservice teacher education, to develop plans to modernize and expand mathematics/science instructional programs, and to implement these plans. The postsecondary portion authorizes $50 million for: congressional scholarships to encourage students to become mathematics/science teachers, summer institutes; upgrading of laboratory equipment; and for research, development, and other activities. Testimony of witnesses (including senators, congressmen, government officials, educators, school superintendents, and others), prepared statements, letters, supplemental materials, and supporting documentation are included. (JN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

● Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY
Government Printing Office
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

HEARINGS ON MATHEMATICS AND SCIENCE EDUCATION
(Part 2)

HEARINGS

BEFORE THE

COMMITTEE ON EDUCATION AND LABOR
HOUSE OF REPRESENTATIVES

NINETY-EIGHTH CONGRESS

FIRST SESSION

ON

H.R. 30

TO PROVIDE ASSISTANCE TO IMPROVE ELEMENTARY, SECONDARY, AND POSTSECONDARY EDUCATION IN MATHEMATICS AND SCIENCE, AND FOR OTHER PURPOSES

HEARINGS HELD IN WASHINGTON, D.C. ON
JANUARY 26-28, 31, 1983

Printed for the use of the Committee on Education and Labor

U.S. GOVERNMENT PRINTING OFFICE
20-201 O WASHINGTON : 1983

COMMITTEE ON EDUCATION AND LABOR

CARL D. PERKINS, Kentucky, *Chairman*

AUGUSTUS F. HAWKINS, California
WILLIAM D. FORD, Michigan
PHILLIP BURTON, California
JOSEPH M. GAYDOS, Pennsylvania
WILLIAM (BILL) CLAY, Missouri
MARIO BIAGGI, New York
IKE ANDREWS, North Carolina
PAUL SIMON, Illinois
GEORGE MILLER, California
AUSTIN J. MURPHY, Pennsylvania
BALTASAR CORRADA, Puerto Rico
DALE E. KILDEE, Michigan
PAT WILLIAMS, Montana
RAY KOGOVSEK, Colorado
HAROLD WASHINGTON, Illinois
MATTHEW G. MARTINEZ, California
MAJOR R. OWENS, New York
FRANK HARRISON, Pennsylvania
FREDERICK C. BOUCHER, Virginia
(Vacancy)

JOHN N. ERLENBORN, Illinois
JAMES M. JEFFORDS, Vermont
WILLIAM F. GOODLING, Pennsylvania
E. THOMAS COLEMAN, Missouri
THOMAS E. PETRI, Wisconsin
MARGE ROUKEMA, New Jersey
LARRY E. CRAIG, Idaho
STEVE GUNDERSON, Wisconsin
STEVE BARTLETT, Texas
RON PACKARD, California
(Vacancy)

CONTENTS

Page

Hearings held in Washington, D.C., on:
- January 26, 1983 ... 1
- January 27, 1983 ... 123
- January 28, 1983 ... 215
- January 31, 1983 ... 435

Text of H.R. 30 follows ... 3

Statement of:
- Bell, Hon. T. H., Secretary of Education, accompanied by Gary L. Bauer, Deputy Under Secretary for Planning, Budget, and Evaluation ... 436
- Barber, Raymond, superintendent of public instruction, Kentucky Department of Education ... 456
- Blake, Dorothy W., president, American Association of School Librarians and coordinator of planning for media resources and utilization, Atlanta Public Schools ... 488
- Bowen, Robert C., vice president, marketing, McGraw-Hill, representing Association of American Publishers, accompanied by Roy H. Millenson, director of education and library affairs ... 477
- Brown, Hon. George E., Jr., a Representative in Congress from the State of California ... 284
- Byron, Rev. William J., president, Catholic University of America ... 340
- Casteen, John, secretary of education for Gov. Charles Robb, Virginia; Floretta McKenzie, superintendent, District of Columbia Public Schools ... 156
- Cooke, Charles, Federal programs coordinator, California Department of Education ... 191
- Dymally, Hon. Mervyn M., a Representative in Congress from the State of California ... 461
- Ellison, Nolen M., chancellor, Cuyahoga Community College ... 326
- Fuqua, Hon. Don, a Representative in Congress from the State of Florida ... 27
- Futrell, Mary Hatwood, secretary-treasurer, National Education Association ... 50
- Gaither, Robert B., chairman, Department of Mechanical Engineering, University of Florida ... 420
- Goldsmith, Joanne, president, National Association of State Boards of Education ... 174
- Greeno, James G., university professor of psychology, Learning Research and Development Center, University of Pittsburgh, representing American Education Research Association ... 580
- Ikenberry, Stanley O., president, University of Illinois ... 298
- Johnston, Richard D., superintendent of schools, Alamosa, Colo ... 474
- Kelly, William, dean, College of Letters and Sciences, Montana State University, accompanied by John W. Layman and Jack M. Wilson ... 362
- Kemble, Eugenia, assistant to the president, American Federation of Teachers ... 465
- Knox, Holly, director, Project on Equal Education Rights, accompanied by Pamela Surko, president-elect, Association for Women in Science ... 180
- LaFalce, Hon. John J., a Representative in Congress from the State of New York ... 124
- Le Fevre, E. Walter, dean of engineering, University of Arkansas ... 383
- McDonald, Alice, deputy superintendent of public instruction, Kentucky Department of Education ... 516
- McCurdy, Hon. Dave, a Representative in Congress from the State of Oklahoma ... 46

Statement of—Continued

Page

- Moreau, David, acting dean, College of Arts and Sciences, University of North Carolina 372
- Norfleet, Morris, president, Morehead State University 318
- Page, Rayma C., president, National School Boards Association 131
- Patterson, Harold, superintendent, Spartanburg, S.C., representing the American Association of School Administrators 104
- Raynolds, Harold, commissioner of education, State of Maine, representing the Council of Chief State School Officers 75
- Rice, Lois, senior vice president for Government affairs, Control Data Corp 150
- Ruch, Charles, dean, School of Education, Virginia Commonwealth University 414
- Skelton, Hon. Ike, a Representative in Congress from the State of Missouri 218
- Thomson, Scott D., executive director, National Association of Secondary School Principals; Prof. Rustum Roy, Brookings Institution 88
- Washburn, Helen, president, American Personnel and Guidance Association 483
- Walgren, Hon. Doug, a Representative in Congress from the State of Pennsylvania 36
- Willoughby, Stephen, president, National Council of Teachers of Math 424
- Wortley, Hon. George C., a Representative in Congress from the State of New York 44
- Yager, Robert E., president, National Science Teachers Association, accompanied by Bill G. Aldridge, executive director, National Science Teachers Association; Walter S. Smith, associate professor, University of Kansas; Jane B. Kahle, president, National Association of Biology Teachers; and Joe P. Meyer, president-elect, American Association of Physics Teachers 139

Prepared statements, letters, supplemental materials, and so forth:

- Barber, Raymond, superintendent of public instruction, department of education, Commonwealth of Kentucky, prepared statement of 458
- Basolo, Fred, office of the president, American Chemical Society, Washington, D.C., letter to Chairman Perkins, dated February 9, 1983 547
- Bell, T. H., Secretary, Department of Education:
  - Letter to Hon. Thomas P. O'Neill, Jr., Speaker of the House of Representatives, enclosing several documents 522
  - Prepared statement of 438
- Blake, Dorothy W., president, American Association of School Librarians and coordinator of planning for media resources and utilization, Atlanta Public Schools:
  - Prepared statement of 492
  - Resolution on the Emergency Mathematics and Science Education Act 498
  - "Student Use of Computers in School," article from School Library Media Quarterly, summer 1982 490
- Bowen, Robert C., chairman, school division, Association of American Publishers, prepared statement of 481
- Brown, Gov. Edmund G., Jr., Governor, State of California, prepared statement of 528
- Brown, Hon. George E., Jr., a Representative in Congress from the State of California, prepared statement of 287
- Byron, Rev. William J., president, Catholic University of America, article entitled "Higher Education's Agenda in Mathematics, Science and Technology Education" 342
- Casteen, John T., III, Secretary of Education, Commonwealth of Virginia:
  - Education Commission of the States, Task Force on Education for Economic Growth, preliminary results of a survey of State initiatives in education 164
  - Information sheet, National Task Force on Education for Economic Growth 161
  - Prepared statement of 158
- Christensen, Bruce, president, National Association of Public Television Stations, prepared statement of 536
- Cooney, Joan Ganz, president, Children's Television Workshop, letter to Chairman Perkins, dated January 31, 1983 549

Prepared statements, letters, supplemental materials, and so forth—Continued

Page

- Cooke, Charles, Federal programs coordinator, California State Department of Education, prepared statement of 194
- Delco, Wilhelmina, chairman, Committee on Education and Job Training, and member, Texas House of Representatives, National Conference of State Legislators, letter to Chairman Perkins, enclosing a policy statement 541
- Dymally, Hon. Mervyn, a Representative in Congress from the State of California, chart from statement 464
- Echelman, Shirley, executive director, Association of Research Libraries, Washington, D.C., letter to Chairman Perkins, dated February 9, 1983 550
- Ellison, Nolen M., chancellor, Cuyahoga Community College:
  - Letter to Frank Mensel, vice president/director of Federal relations, enclosing an article entitled "Putting America Back to Work" 334
  - Prepared statement of 331
- Gaither, Robert B., chairman, Department of Mechanical Engineering, University of Florida, prepared statement of 422
- Glenn, Hon. John, a U.S. Senator from the State of Ohio, prepared statement of 15
- Goldsmith, Joanne T., president, National Association of State Boards of Education, attachment 178
- Great Lakes Colleges Association and the Associated Colleges of the Midwest, statement of 535
- Greeno, James G., university professor, University of Pittsburgh, prepared statement on behalf of American Education Research Association 502
- Hatwood-Futrell, Mary, secretary-treasurer, National Education Association, prepared statement of 53
- Ikenberry, Dr. Stanley O., president, University of Illinois:
  - Prepared statement of 301
  - "Today's Problems, Tomorrow's Crisis," a report of the National Science Board 306
- Johnston, Richard D., superintendent of schools, Alamosa, Colo., prepared statement of 475
- Keller, Edward P., deputy executive director, National Association of Elementary School Principals, letter to Chairman Perkins, dated February 28, 1983 551
- Kemble, Eugenia, special assistant to the president, American Federation of Teachers, AFL–CIO, prepared statement of 469
- Kelly, William H., past president, American Association of Physics Teachers, prepared statement of 365
- Knox, Holly, director, Project on Equal Education Rights:
  - "Peer Study Summary," article entitled from Michigan Peer Math Report 182
  - Prepared statement of 186
- LaFalce, Hon. John J., a Representative in Congress from the State of New York, prepared statement of 126
- Lacot, Maria Socorro, secretary of education, Commonwealth of Puerto Rico, letter to Chairman Perkins, enclosing a statement of 544
- LeFevre, Walter E., dean of engineering, University of Arkansas:
  - "About Education, Schools' Improvement Goes Unrewarded," from the New York Times, Tuesday, December 28, 1982 395
  - "Adding up the Answer . . .," from the Wilmington Delaware News, letter entitled 393
  - Knapp, Dr. Edward A., Director, National Science Foundation, Washington, D.C., letter to, January 7, 1983 399
  - "Mathcounts Orientation for NSPE Societies and Chapters," article entitled 404
  - "Math-science Crisis," article from Chicago Sun-Times, Tuesday, December 28, 1982 396
  - Prepared statement of 386
  - "Raise Academic Standards, Virginian Ask Governors," from Washington Post, August 8, 1982 394
  - "The CNA Insurance Companies," article entitled 397
- McDonald, Alice, deputy superintendent of public instruction, Kentucky Department of Education, prepared statement of 517

Prepared statements, letters, supplemental materials, and so forth—Continued

Page

McKenzie, Floretta, superintendent, District of Columbia Schools, prepared statement of 169
Mehlinger, Howard, dean, School of Education, Indiana University, Bloomington, Ind.:
  "Facing the Crisis of Mathematics and Science Education in Indiana Elementary and Secondary Schools," a report entitled 554
  Letter to Chairman Perkins, dated February 1, 1983 553
Moreau, David H., acting dean, College of Arts and Sciences, University of North Carolina:
  Prepared statement of 375
  "Scientific Equipment: Inventory and Needs" 378
Norfleet, Morris L., president, Morehead State University, prepared statement of 323
Page, Rayma C., president, National School Boards Association, prepared statement of 135
Pallak, Michael S., Ph. D., executive officer, American Psychological Association, letter to Chairman Perkins, dated February 2, 1983 552
Panetta, Hon. Leon E., a Representative in Congress from the State of California, prepared statement of 520
Press, Frank, president, National Academy of Sciences, written statement by 532
Raynolds, Harold, commissioner of education, State of Maine, representing the Council of Chief State School Officers:
  "Need for a New 'National Defense Education Act'," policy paper entitled 83
  Prepared statement of 78
Reed, Earl, superintendent, Morgan County Schools, West Liberty, Ky., letter to Chairman Perkins, dated January 17, 1983 531
Roy, Rustum, professor, Science and Public Policy Fellow, the Brookings Institution, prepared statement of 96
Ruch, Dr. Charles, dean, School of Education, Virginia Commonwealth University, prepared statement of 417
Sandberg, John E., dean, College of Education, and James J. Bosco, director, Center for Educational Research, National Research, Western Michigan University:
  "A Plan to Improve Math Education at the Elementary and Middle School Level," prospectus, submitted by 431
  "A Plan to Improve Science Education at the Elementary and Middle School Level," prospectus, submitted by 432
Simon, Hon Paul, a Representative in Congress from the State of Illinois and chairman, Subcommittee on Postsecondary Education:
  Opening statement of, Jan. 28, 1983 216
  Prepared statement of, Jan. 26, 1983 15
Skelton, Hon. Ike, a Representative in Congress from the State of Missouri:
  "Engineering Manpower: a Survey of the National Problem and the Problem in the Department of Defense": Prepared by Paul Zinsmeister, specialist in national defense, foreign affairs and national defense 261
  "United States Supply and Demand of Scientists and Engineers; Effects on Defense Research and Technology," prepared by Edith F. Cooper, analyst in social science, Science Policy Research Division, Congressional Research Service 222
Smith, Robert L., executive director, Council for American Private Education, Washington, D.C., letter to Chairman Perkins, dated January 26, 1983 542
The Edison Electric Institute, prepared statement of 540
Thomson, Scott D., executive director, National Association of Secondary School Principals, prepared statement of 90
Walgren, Hon. Doug, a Representative in Congress from the State of Pennsylvania, prepared statement of 43
Washburn, Helen R., president, American Personnel and Guidance Association, prepared statement of 485
Webb, H. Jack, superintendent, Greenup County Schools, Greenup, Ky., letter to Chairman Perkins, dated January 18, 1983 531

Prepared statements, letters, supplemental materials, and so forth—Continued

Page
Williams, Hon. Pat, a Representative in Congress from the State of Montana, prepared statement of 20
Willoughby, Stephen W., president, National Council of Teachers of Mathematics, prepared statement of 427
Yager, Robert E., president, National Science Teachers Association:
Prepared statement of 141
"The Teacher Crisis in Secondary School Science and Mathematics," article entitled 148

HEARINGS ON MATHEMATICS AND SCIENCE EDUCATION

Part 2

WEDNESDAY, JANUARY 26, 1983

House of Representatives,
Committee on Education and Labor,
Washington, D.C.

The committee met, pursuant to call, at 9:40 a.m., in room 2175, Rayburn House Office Building, Hon. Carl D. Perkins (chairman of the committee) presiding.

Members present: Representatives Perkins, Biaggi, Miller, Kildee, Williams, Boucher, Goodling, Roukema, Gunderson, and Bartlett.

Staff present: John F. Jennings, counsel; Nancy Kober, legislative specialist.

Chairman Perkins. This morning the Committee on Education and Labor is commencing a 4-day series of hearings on H.R. 30, the Emergency Mathematics and Science Education Act.

This legislation addresses some of the most pressing needs in education today: Teacher shortages in math and science and declining student achievement and preparation in these subjects.

Last summer when the Subcommittee on Elementary, Secondary, and Vocational Education conducted three hearings on math and science education we heard some alarming statistics:

Forty-three States indicated a shortage of secondary math teachers in a 1981 survey.

One-half of all high school graduates take no mathematics or science beyond 10th grade.

There has been a steady decline in recent years in the science and higher level mathematics achievement scores of 17-year-olds as measured by the national assessment of educational progress.

The problems we face today in mathematics and science education threaten to undermine our status in the international marketplace and compromise our national defense. I firmly believe that shoring up our mathematics and science education programs should be a priority across the country and a priority of the 98th Congress.

The bill we have introduced, along with Congressmen Simon, Goodling and 56 other cosponsors, amends the National Defense Education Act of 1958. H.R. 30 authorizes $300 million for fiscal year 1984 and an open-ended amount for fiscal year 1985 for programs to improve mathematics and science education at the elementary, secondary, and postsecondary levels.

Under the elementary and secondary portion of the bill, $250 million is authorized for formula grants to State educational agencies, which must pass through 95 percent of the funds to local educational agencies. The local school districts can use their funds for inservice teacher training, to develop plans to modernize and expand math and science instructional programs, and to implement these plans.

The postsecondary portion of the bill authorizes $50 million for congressional scholarships to encourage students to become math and science teachers; for summer institutes for teachers; for upgrading of laboratory equipment; and for research, development, and other activities.

I am also, of course, pleased that the President in his state of the Union address last night stated that the administration will have a proposal in this area.

I look forward to hearing the comments of all of our distinguished witnesses and all the members who want to make a statement on the problem. We have with us today several Members of Congress, the Honorable Don Fuqua, chairman of the Science and Technology Committee, one of the most valuable Members in this Congress. We all know him. He has worked in this area for several years. And we likewise have Doug Walgren from Pennsylvania, an outstanding Member of Congress, Dave McCurdy from Oklahoma, and George C. Wortley.

[Text of H.R. 30 follows:]

I

98th CONGRESS
1st Session

H. R. 30

To provide assistance to improve elementary, secondary, and postsecondary education in mathematics and science, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

January 3, 1983

Mr. Perkins (for himself, Mr. Simon, Mr. Goodling, Mr. Ford of Michigan, Mr. Biaggi, Mr. Williams of Montana, Mr. Weiss, Mr. Lehman of Florida, Mr. Oberstar, Mr. Smith of Iowa, Mr. Rahall, Mr. Bevill, and Mr. Boucher) introduced the following bill; which was referred to the Committee on Education and Labor

---

A BILL

To provide assistance to improve elementary, secondary, and postsecondary education in mathematics and science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Emergency Mathematics and Science Education Act".

Sec. 2. The National Defense Education Act of 1958 is amended by adding the following new title:

"TITLE VI—EMERGENCY MATHEMATICS AND SCIENCE EDUCATION

"PART A—ELEMENTARY AND SECONDARY ASSISTANCE

"FINDINGS

"SEC. 601. The Congress finds that in order to increase our Nation's economic productivity and ensure an adequate number of high school graduates to serve in the Nation's defense, it is necessary (1) to improve the quality of instruction and levels of achievement in mathematics and science at the elementary and secondary levels, and (2) to increase the supply and qualifications of teachers of mathematics and science at the elementary and secondary levels.

"AUTHORIZATION OF APPROPRIATIONS TO THE DEPARTMENT OF EDUCATION

"SEC. 602. (a) There are authorized to be appropriated to the Department of Education to carry out this part $250,000,000, for the first fiscal year beginning after the date of enactment of this Act, and such sums as may be necessary for the second such year.

"(b) No funds are authorized to be appropriated to carry out this part for any fiscal year if the amount appropriated to carry out chapter 1 of the Education Consolidation and Improvement Act of 1981 for such fiscal year does not equal or exceed the amount appropriated to carry out such chapter for the preceding fiscal year.

"ALLOCATION OF FUNDS

"SEC. 603. (a) The amount appropriated pursuant to section 602 for any fiscal year shall be allocated among the States in the same manner as is required by the second sentence of section 302(a)(1) of this Act, except that Puerto Rico shall be considered a State.

"(b) From the amount allocated to any State pursuant to subsection (a) the State educational agency may reserve not more than 5 percent of such amount for the conduct of State administration and planning activities pursuant to section 605.

"(c) The remainder of the amount allocated to any State pursuant to subsection (a) shall be allocated by the State educational agency among the local educational agencies in that State as follows:

"(1) Three-fourths of such remainder shall be allocated among local educational agencies so that each such agency receives an amount which bears the same ratio to the amount allocated under this paragraph in that State as the population aged 5 to 17, inclusive, in the school district of such agency bears to the total population aged 5 to 17, inclusive, in that State.

"(2) One-fourth of the remainder shall be allocated among local educational agencies on the basis of such other factors as may be established by the Secretary by regulation, such as the number of children from low income families.

"USE OF FUNDS BY LOCAL EDUCATIONAL AGENCIES

"SEC. 604. (a) Funds made available to any local educational agency pursuant to this part shall be used, in accordance with a local application certified to meet the requirements of this part by the State educational agency for the improvement of education in mathematics and science. Such uses may include—

"(1)(A) inservice teacher training for recertification in mathematics and science, for computer competency, and for upgrading and modernizing mathematics and science knowledge, and (B) inservice training for administrative personnel and for members of local boards of education;

"(2) evaluation of local resources for education in mathematics and science;

"(3) development of plans for modernizing and expanding courses of instruction in mathematics and science, and, where feasible, the implementation of those plans;

"(4) the development of innovative resources in mathematics and science, including the use of emerging technologies and the development of curriculum; and

"(5) the use of important community resources to achieve the purposes of this Act, including teachers, universities, the business sector, public agencies (such as libraries and museums), and other institutions, agencies, and individuals.

"(b) Two or more local educational agencies are authorized to combine the funds they receive under this part for jointly operated programs in carrying out the purposes of this part.

"(c)(1) To the extent consistent with the number of children in the school district of each local educational agency who are enrolled in private elementary and secondary schools, such agency shall make provision for including special educational services and arrangements (such as dual enrollment, educational radio and television, and mobile educational services and equipment) in which such children can participate and meeting the requirements of this section. Expenditures for educational services and arrangements pursuant to this subsection for children in private schools shall be equal (taking into account the number of children to be served and the needs of such children) to expenditures for children enrolled in the public schools of the local educational agency.

"(2) The requirements of paragraph (1) may be waived in the same manner as the requirements of section 557(a) of the Education Consolidation and Improvement Act of 1981 and shall be subject to judicial review in accordance with section 557(b)(4) of such Act.

"STATE USE OF FUNDS

"SEC. 605. (a) Funds made available to any State educational agency from the allocation under section 603(b) shall be used, in accordance with a State plan certified to meet the requirements of this part by the Secretary—

"(1) to cover the cost of administration with respect to programs conducted by local educational agencies with funds made available under this part;

"(2) to develop statewide strategies to upgrade teacher certification standards;

"(3) to make technical assistance available to local educational agencies, upon their request, to assist them in carrying out the purposes of this Act; and

"(4) to conduct inservice training programs for personnel of the State educational agency and other State agencies with responsibility for education programs.

"(b) Each State plan shall set out the allocation of funds received under this part among local educational agencies.

"PART B—POSTSECONDARY ASSISTANCE

"CONGRESSIONAL SCHOLARSHIPS

"SEC. 621. (a) Sums available for the purposes of this section shall be used to award congressional scholarships in accordance with this section to 300 individuals in the first fiscal year beginning after enactment of this section, and to 600 individuals in the second such year. Such scholarships may not exceed an amount equal to the tuition and fee expenses of any recipient for two academic years (of undergraduate or graduate education) and may be paid only upon proof of achievement of above average grades in the preceding academic year.

"(b) Each Member of the House of Representatives and the Senate may nominate two individuals for selection as congressional scholars. Such nominations shall be supported by suitable academic credentials and recommendations and include a personal statement by the individual expressing a commitment to pursue a career in teaching.

"(c) Congressional scholars shall be selected by a committee composed of the Librarian of Congress (acting as chairman), the Secretary of Education, the Director of the Office of Science and Technology Policy, one individual appointed by the Speaker of the House of Representatives, and one individual appointed by the majority leader of the Senate. Selections shall be made in accordance with regulations prescribed by the Secretary of Education after consultation with the Librarian of the Congress and the Director of the Office of Science and Technology Policy. Individuals shall be selected on the basis of merit and shall be pursuing a course of instruction in science, mathematics, or other course of study identified by the chief State school officer of the pertinent State as having a critical shortage of qualified teachers. The committee shall ensure that the individuals so selected include individuals who are unrepresented or underrepresented in the respective disciplines.

"(d) To be eligible for selection as a congressional scholar, an individual shall have completed the equivalent of at least three years toward a baccalaureate degree and shall have formally expressed the intention to teach elementary or secondary school mathematics, science, or other appropriate subject for at least five years.

"(e) Each congressional scholar shall be obligated to teach for at least five years from the date of initial employment, or to repay the total amount of the scholarship, plus interest at a rate prescribed by the Secretary of Education.

"POSTSECONDARY MATHEMATICS, SCIENCE, AND TECHNOLOGICAL IMPROVEMENT

"SEC. 622. (a) Ten per centum of the funds appropriated to carry out this part for fiscal year 1984 or 1985 shall be made available by the Secretary of Education for grants to institutions of higher education for mathematics and science improvement and employment-based education programs in new and emerging technologies.

"(b) Twenty-five per centum of the funds appropriated to carry out this section for fiscal year 1984 or 1985 shall be made available by the Secretary to community and junior colleges for programs of mathematics and science improvement and employment-based education programs in new and emerging technologies.

"SUMMER INSTITUTES

"SEC. 623. From the funds available for this section for fiscal year 1984 or 1985, the Secretary of Education shall make grants to institutions of higher education to support summer institutes and workshops for teachers and supervisors of mathematics and science programs. Such institutes may also be conducted in such other areas of national need, as determined by the Secretary of Education.

"STRENGTHENING EDUCATIONAL RESEARCH AND DEVELOPMENT

"SEC. 624. (a) The Director of the National Institute of Education, in consultation with appropriate Federal agencies, shall conduct an investigation of effective methods of instruction in mathematics and science. Such investigation may include support for—

"(1) applied research in physical sciences and pedagogical studies, particularly with respect to instruction at the secondary level;

"(2) research on the use of instructional technologies (including software); and

"(3) analysis of local and institutional policies enhancing or inhibiting the recruitment, retention, and upgrading of mathematics and science faculties.

"(b) There are authorized to be appropriated to the Department of Education and made available to the National Institute of Education to carry out this section not more than $10,000,000 for each of the fiscal years 1984 and 1985.

"UPGRADING LABORATORY EQUIPMENT AND FACILITIES

"SEC. 625. (a) The Congress finds that (1) the outmoded condition of instructional equipment and research and laboratory facilities is a principal component in the current crisis in mathematics and science education, (2) the absence of state-of-the-art equipment and facilities has both immediate consequences for the instruction of students and significant long-term consequences for the ability of the United States to remain scientifically and technologically competitive, and (3) a balanced program is therefore required to make the acquisition of equipment and renovation of laboratories an allowable component of all Federal research grant proposals.

"(b) The Secretary of Education, from the funds available for this section, shall make challenge grants available to provide not more than one-third of the cost of—

"(1) the purchase of modern scientific equipment for use in teaching and research;

"(2) programs to train faculty in the use of new laboratory and research equipment; and

"(3) sharing scientific and engineering equipment among academic and business laboratories and research centers.

"(c) The amount which may be made available to carry out this section shall not exceed $50,000,000 for fiscal year 1985.

"(d) The Secretary of Education, in consultation with other appropriate Federal agencies, shall, prior to September 30, 1984, assess the current need for improvements in and purchases of laboratory equipment and facilities.

PART C—LIMITATIONS ON APPROPRIATIONS

LIMITATION

"SEC. 641. Notwithstanding any other provision of this title, the total amount which may be appropriated pursuant to this title for fiscal year 1984 shall not exceed $300,000,000 of which—

"(1) not more than $250,000,000 shall be available for part A of this title; and

"(2) not more than $50,000,000 shall be available for part B of this title.".

MINORITY INSTITUTIONS SCIENCE IMPROVEMENT

SEC. 3. Section 406A of the General Education Provisions Act (as added by the Education Amendments of 1980; 94 Stat. 1497) is amended by inserting "and for each succeeding fiscal year ending prior to October 1, 1985" after "for fiscal year 1981" in the matter preceding paragraph (1).

○

Chairman PERKINS. Let me ask all the Members to come around and to take seats around the table. Mr. Fuqua, we are going to let you lead off this morning. We are delighted to have you here.

I also want to note that Congressman Simon, chairman of the Subcommittee on Postsecondary Education, regrets he cannot be here this morning. He has a statement for the record.

In addition, Senator John Glenn was to have testified but, unfortunately, was not able to make it. He also has a statement for the record.

[The prepared statements of Congressman Paul Simon and Senator John Glenn follow:]

PREPARED STATEMENT OF HON. PAUL SIMON, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF ILLINOIS AND CHAIRMAN, SUBCOMMITTEE ON POSTSECONDARY EDUCATION, JAN. 26, 1983

Today begins a series of hearings on approaches to lessen the problem of math and science illiteracy and under preparation in our nation and to ensure quality instruction for elementary and secondary school students in areas of math, science and other sensitive and important fields which may include special education and foreign languages. While our current shortage of teachers has been documented in math and science, I do not think we ought to overlook other basic areas which are just as important to our children's education—English, history, social sciences and the arts. However, it is clear that the most pressing need right now, reflected in the dislocation of workers from heavy industry and worker shortages in high technology industries, is for comprehensive and quality curricula in math and science.

The problem has been with us for some time, and is reflected in math and science requirements for high school graduation. In my own state of Illinois, more than half of all high school graduates did not take math or science beyond the 10th grade. Even our best high school graduates are often required to take remedial science and math courses before entering certain undergraduate programs, especially in engineering. This nation does not have enough math and science teachers, and those who are teaching often leave the profession for higher paying jobs in industry. It has been estimated that half of all math and science teachers are not qualified, and many states fill open math and science classrooms with teachers who are temporarily certified as emergency measures. These are more school districts in the United States than there are physics teachers.

I commend Chairman Perkins for holding these joint hearings of the Elementary, Secondary and Vocational Education Subcommittee and the Postsecondary Education Subcommittee. The bill H.R. 30 is a composite of programs aimed at preparing more and better science and math teachers, and encouraging school districts to upgrade math and science faculty, facilities, and curriculum requirements. H.R. 30 rightly recognizes the local responsibility in the area of education, and the first sections of H.R. 30 allow for flexibility and independence through a program of general aid to school districts.

The postsecondary aspects of H.R. 30 are more directed. They provide incentives to students of education who concentrate in math and science through merit scholarships, funding for instructional equipment upgrading, programs of research into the scope of the problem of math and science preparation and in-service and summer institutes for teachers in the field.

H.R. 30 is not the solution to math and science education problems in our country. It is a beginning and these hearings will add to our knowledge of the problem and what might be solutions, including what can and should be done at the federal level.

PREPARED STATEMENT OF HON. JOHN GLENN, A U.S. SENATOR FROM THE STATE OF OHIO

Mr. Chairman, I want to congratulate you for organizing this hearing so early in the first session of the 98th Congress on an issue of such vital importance to the American people. You are continuing to set a superb example of leadership in the area of education and deserve all the thanks and plaudits which have been given to you in your long and distinguished career as the Chairman of this Committee.

Mr. Chairman, my testimony at this hearing stems from my concern about the declines we have experienced in recent years in the effectiveness of our educational system. Teaching as a profession does not enjoy the respect and prestige once accorded to it by the outside community and which it still richly deserves. Remuneration for teachers across-the-board is abysmal and is getting worse. We are suffering from a lack of opportunity and support for scholars of all kinds. This suggests, Mr. Chairman, that we shall sooner or later have to mount a broad-scale attack on the problems afflicting our educational system in the United States. But I recognize that at a time when budget deficits are astronomical, due to the misguided and even destructive policies of the present Administration, it is going to be exceedingly difficult to mediate among the various conflicting demands on monetary resources of the federal government, and it is therefore not inappropriate to target resources in order to deal with the most pressing problems.

Certainly one of the most pressing problems in education we face today is in the area of precollege math and science. Few would disagree with the proposition that the role of science and technology is increasing throughout our society. In business, in government, in the military, in occupations and professions where it never before intruded, science is becoming a key to success. Unfortunately, our educational system is not providing the kind of background in science and technology that is needed for our young people to enter the work-force in jobs requiring an understanding of high technology. Students who take no more mathematics and science after their tenth year in school have effectively eliminated, by the age of 16, the possibility of science or engineering as a career. Even as our need for scientific and engineering personnel increases, we find ourselves in danger of drawing down the pool from which such personnel will come. Our schools are simply not doing the job that needs to be done of producing young people who are highly literate in science and mathematics. Part of the reason is the lack of qualified teachers in those subjects at the precollege level. If this situation continues, we will not only fail to meet the needs of the armed forces and the industrial and public service enterprises in the United States, but we will widen the gap between public understanding of science and technology and the requirements of citizenship in a participatory democracy.

There are a number of facts that can be pointed to indicate the seriousness of the problem.

There are 8.3 percent fewer math teachers and 5.5 percent fewer physical science teachers than are needed in our schools and this does not take quality into account.

Average SAT scores have dropped steadily since 1963 (except for a slight rise this last year). The proportions scoring above 500 on the math SAT has dropped 15 percent since 1967 while the proportion scoring below 300 in both math and verbal tests rose 38 percent. These numbers are even worse when we talk about students majoring in education, i.e., the teachers of the future. From 1972 to 1980 SAT verbal scores for education majors dropped from 418 to 339, a loss of 79 points, while their SAT math scores dropped 31 points, going from 449 to 418. This is a much steeper decline than the national averages for all students in the same time period. As Ernest Boyer, President of the Carnegie Fund for the Advancement of Learning has stated:

"The quality of education in this national can rise no higher than the quality of teachers. If public support continues to decline, and if teaching standards continue to go down, the intellecutual and economic future of this nation will be threatened".

The national assessment of educational progress results for mathematics in 1978 showed a sharp decline in the ability of 9-year olds, 13-year olds, and 17-year olds to deal with any item that requires understanding and interpretation beyond the rudimentary arithmetic skills. Only about ⅙ of high school graduates have taken junior and senior level courses in science and mathematics. One-half of all high school graduates take no mathematics or science beyond the 10th grade and only one-half of the students entering college have had any significant exposure to physical science or advanced mathematics beyond the 10th grade.

The International Project for the Evaluation of Education Achievement ranked Japanese 13-year olds highest in mathematical achievement among 12 countries, including the U.S. and several European countries. Mathematics instruction has a more rapid pace in Japan than in the U.S. and much higher proportion of students take the more advanced courses. In Germany, the general preparation is similar. Partly as a result, in Japan 20 percent of all baccalaureate and about 40 percent of all masters degrees are granted to engineers, and these figures have been nearly stable for the past 10 years. This compares with a figure of about 5 percent at each degree level in the U.S.

While there is no doubt that the Soviet Union has problems with its educational system, we should pay head to the fact that whereas only about 500,000 Americans take calculus during their last year in high school or their first in college, 5 million Soviet students have calculus as part of their high school curriculum. In addition, all youngesters in the USSR are required to complete 5 years of physics, 4 of chemistry, and up to 4 of biology, depending on whether they attend specialized or general secondary schools. The Soviet Union was reputed to have graduated approximately 300,000 engineers last year as opposed to a total of about 65,000 engineers for the United States.

Over the past 10 years, there has been a 78 percent decline in the production of secondary school mathematics teachers and a 64 percent decline in the production of secondary school science teachers in the United States. We are losing the teachers we already have due to low salaries and poor working conditions. Almost 5-times more science and math teachers left teaching last year for employment in nonteaching jobs than left due to retirement.

43 states have reported shortages of high school math teachers; 42 states have reported shortages of high school physics teachers; and 38 states have reported shortages of high school chemistry teachers.

While the supply of math and science teachers has fallen drastically, vacancies have not dropped commensurately. That suggests that positions that cannot be filled through new hiring of qualified instructors are being filled by teachers with lower subject matter qualifications or by the transfer of teachers from other subject areas. It is therefore not surprising that a recent nationwide survey indicated that a sizable number of secondary school science and mathematics teachers feel inadequately qualified to teach one or more of their courses. The National Science Teacher Association reported in 1981 that among newly employed science teachers the previous year, more than 50 percent were unqualified in the opinion of their supervisors.

Only half the states require at least one science course before high school graduation; five require two or more courses and the rest mandate none. In seven states the mandated course is physiology and in five states health and hygiene courses satisfy the science requirements.

Mr. Chairman, this litany of horrible facts undoubtedly raises some questions in the minds of those who have witnessed the evolution of our educational programs in the last 25 years. When Sputnik I was launched into orbit by the USSR, our nation galvanized itself to become first in space, and more generally, to improve our science and technology. Science education in our schools became a prime concern. In 1959, 46 percent of the National Science Foundation budget was devoted to education, up from 17 percent in 1955. Two-thirds of the moneys went into precollege programs, including teacher training institutes that kept instructors up-to-date. Today, virtually no foundation money goes into such pograms. Indeed, President Reagan in his fiscal year 1983 recommendations zeroed out all funds for precollege science education. As a result of that, the Director of NSF disestablished the science education division. Interestingly, many teaching materials for science education that were produced through NSF programs are widely used in Japanese schools, while their use in the United States has declined sharply as money to buy them has become scarce.

Now some people might say, Mr. Chairman, that since we did spend approximately a billion dollars over a 25-year period on precollege math and science education, shouldn't we have expected much better results than we got? First, we must put this expenditure into perspective. There has been a steady decline of funding for science education since 1967. Leaving that aside, the average yearly amount of money spent for science and math education during the 25-year period from 1957 to 1982 was $40 million. Since there are 16,000 school districts in the United States, that amounts to an annual expenditure of $2,500 per school district. Even if this money had been spent in the most efficient manner possible, it would be unreasonable to have expected a major overhalul of science and math education in the United States stemming from this expenditure alone.

Mr. Chairman, after the President zeroed out all funds for science education except for graduate fellowships in his fiscal year 1983 budget, he asked the National Science Foundation to set up a Commission on Precollege Science and Math Education to tell us what the problem is and what ought to be done about it. I have great respect for the members of that Commission and I shall study the Commission's report carefully, but we have known for some time what some of the major problems are and we can take action now to alleviate them.

Mr. Chairman, yesterday, my colleague, Congressman Dave McCurdy and I simultaneously introduced two bills to deal with the issues I have been discussing. The first bill, the Precollege Mathematics and Science Teacher Assistance Act, authorizes an educational assistance program consisting of low-cost forgiveable loans to college students who will major in science or mathematics and will go on to teach at the precollege level.

These 9 percent interest loans are forgivable over a 4-year period of teaching. The bill is an incentive for young people with talent in the areas of science and mathematics to enter precollege math and science teaching for at least a few years. By so doing, important progress can be made in strengthening the quality of teaching and the depth of the math and science curricula in our schools. The cost of this program would be relatively modest. An informal estimate by the Congressional Budget Office suggests that the program might cost $12 million in its first year of operation and then reach a peak of about $60 million per year after a few years.

The second bill that I have introduced along with Congressman McCurdy is the Math and Science Education Act. This bill provides for a 50 percent tax credit to employers who hire precollege science and math teachers for the summer months and give them experience in the applications of high technology. A similar tax credit is also available to any firm which gives a qualified and certified employee a certain amount of time off to teach science and mathematics in the public school system. Mr. Chairman, the tax credits will provide incentives to hire science and math teachers for the summer, thereby giving them a source of income that will allow them to stay within the school system. Since the bill specifies that they are to be engaged in some work involving applications of high technology, it will also give these teachers some additional experience that they can bring back to the classroom. The provision of tax credits for giving qualified and certified employees release time to teach in the public school system will enable the schools to find the resource specialists that they need, as well as to get some of the better science and math teachers that may have left the system for jobs in private industry to go back to the school system at least on a part-time basis.

The industrial sector of our economy has given and is giving significant support relative to the past to science and engineering training at the college level, but help for elementary and secondary schools has bee sporadic at best. The role that industry could play is evidenced by the positive impact that has been had in those elementary schools which have had science specialists to call on. If every elementary school had a competent science specialist to serve as both teacher and resource person, science education would very definitely be improved. Some farsighted corporations such as Monsanto have been active in these areas and I applaud them for it, but much more can and should be done. I believe the tax credit incentives in the Math and Science Education Act will induce many corporations to make a positive contribution to resolving our science and math education problems.

I should also say Mr. Chairman, that although my bills do not directly address the issue, it is important that steps be taken to improve the level of training in science and math for persons who possess teaching certificates and are in the system today. I am presently examining a number of proposals for teacher training programs that could be used to alleviate shortages in qualified math and science teachers. It is my intention to support an appropriate teacher training program as part of a package of initiatives which would include the measures I have discussed today in order to deal adequately with the crisis in math and science education that our country faces.

I have not had an opportunity as yet to examine in detail your own proposals in this area as contained in H.R. 30 Mr. Chairman, but I look forward to doing so with the hope that we can all work together to fashion a legislative response to this pressing issue that will enable quick action to be taken in both houses.

I know that you share my feeling, Mr. Chairman, that we cannot expect an education renaissance in the United States with the federal government standing by as either a disinterested observer or at most, a cheerleader for reforms and innovations that few localities and states can afford. For the sake of our economic health, our national security, and the cultural legacy we owe to future generations, we should expect and demand more than passivity based on ideological rigidity from our national leaders. I believe that education deserves to be among the top issues in our domestic agenda. If the Reagan Administration continues to approach these problems with more studies and more excuses for avoiding action, then I believe the American people will demand new leaders who see more clearly that education is the foundation of our success as a society.

Thank you very much.

Chairman PERKINS. I understand the gentleman from Pennsylvania, the ranking member on this committee, Mr. Goodling, wants to make a statement before you commence, Don.

Mr. **Goodling**. Thank you, Mr. Chairman. I am happy to be cosponsor with the chairman on this piece of legislation, not because I think it is the final or it is the best or anything of that nature, but because it gives us a starting point to study a very critical problem. I think the bill provides a good basis for subcommittee action. I plan to offer some amendments that I hope will improve targeting of funds and institute State-determined performance criteria.

I want to make sure as we go through this whole exercise that we really target in on those elementary teachers who have an almost impossible job of trying to be prepared to teach every subject. I have said many times that if we wait until we get to the secondary level, we will have lost all the students who will be potential math and science students in the future. We have to give help to those teachers at the elementary level where an interest can be created in young people to get them to want to deal with science and mathematics. I hope that by the time we have finished with all our hearings we will be able to put forth a program that will not just throw money at a problem, but that will truly offer some solutions to what I consider one of our most critical problems.

I was glad that the President sees this as a critical problem, too. I said to the chairman I think he has one proposal that I think will be worthwhile including in the bill. It deals with the retraining of some of the math and science people who do not have jobs at the present time. They are very capable, but the jobs are not there at the present time. Perhaps we can coax them into the teaching field to help with our critical problem and by offering to train them for that purpose. I am looking forward to our committee coming up with an outstanding proposal that will in fact in the long run help solve that critical problem so we can compete as leaders as we have in the past. We want to make sure that we can compete with some of the leading countries throughout the world.

Chairman **Perkins**. Mr. Biaggi, I understand, wants to make a statement.

Mr. **Biaggi**. I would rather defer on any extended statement except to point out that this committee has been in the vanguard. I was gratified last night to hear the President refer to our Nation's concern and his interest in the advancement of science and the study of science and mathematics.

That is all, Mr. Chairman.

Chairman **Perkins**. Mr. Williams.

Mr. **Williams**. Thank you, Mr. Chairman.

I have a lengthy opening statement which I would like permission to make part of the record. And at this time I want to make brief opening remarks.

It would be a mistake to think of the present crisis in math and science education as simply one facing only American education. Yes, America faces a crisis in math and science education, a severe and growing shortage of math and science teachers, and the following numbers bear this out.

Last year in New Hampshire only one college graduate planned to become a math teacher. I know New Hampshire is small, but it is not that small.

In New York, the second most populous State in this Nation, only 32 college graduates planned on careers as junior or senior high school math teachers. With the junior and senior high school enrollment of well over 1 million students, 32 teachers won't teach much math!

And in the State of Texas last year, seven college graduates became math teachers.

As you all know, similar figures can be cited in almost every State. The shortage is real and it is very serious and unless we take action very soon, these shortages are going to become even more severe, because today's math and science teachers are as a group mostly middle-aged. At the same time, even though school enrollments are currently dropping, they will rise again by the end of this decade, and these two factors, the graying of America's math and science teachers, and the increase in enrollments in the 1990's, will interact to seriously exacerbate the present shortage situation.

Already Japan, the Soviet Union, and Republic of China provide more intensive math and science education to their youth. Their intent is clear, to educate individuals to participate successfully in an increasingly more competitive high-technology marketplace. But in addition to their strong educational commitments, these countries are equally committed to maintaining a high level of basic scientific research which is so necessary for any country's continued economic development.

Japan, for example, is obviously aware of the very direct relationship between math and science education, support of scientific research, and economic growth. In addition to insuring that her citizens receive a quality math and science education, Japan is pouring billions of dollars into developing Tsukuba, the science city. Through this basic scientific research effort, Japan seeks to become the world leader in engineering plastics, compound semiconductors, carbon and optical fibers, industrial robots, telecommunications, and other high-technology fields.

We can do no less, and in fact we should do much more. I hope that we can use these hearings on the Emergency Mathematics and Science Education Act as resources and that over the next few days we can be exposed to the best advice of many experts who are also concerned citizens and then use these resources to recommend and help enact legislation that will turn us away from this crisis in math and science education.

[The prepared statement of Congressman Pat Williams follows:]

PREPARED STATEMENT OF HON. PAT WILLIAMS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF MONTANA

I do not think it overstatement to label the situation that brings us together today a crisis. A crisis is a turning point; a decisive moment, and the actions that are taken to resolve a crisis are always actions that either make the situation better or worse. There is no middle ground. Based on what we began here today, we can either move the nation forward or we can further retard our national development. So, my friends, make no mistake. We are at a crisis in this country with respect to math and science education, and we must take positive and immediate steps if the United States is to continue to enjoy a satisfactory level of prosperity, productivity, and security.

It would be mistake to think of this crisis as simply one facing American education, however. True, we do face a crisis in math and science education, for we face a severe and growing shortage of math and science teachers in our nation's schools: a significant majority of states have and continue to report difficulties in obtaining math and science teachers. This shortage is due in large part to two factors: experienced teachers are leaving the classroom for non-teaching, higher-paying jobs in technology-based industries, and fewer individuals are choosing to enter math and science education as a profession.

Translating these statements about shortages into numbers, we find statistics like the following:

Experienced math and science teachers are leaving classroom teaching for non-teaching jobs at the rate of 4 percent per year (based on 1980–1981 data). Of those currently remaining in the classroom, one-fourth have indicated that they expect to leave teaching in the near future.

Since 1972 there has been a 77 percent decline in the number of high school math teachers prepared in 600 teacher-training programs nationwide. [National Council of Teachers of Mathematics]

In a 1981 survey of 122 teacher education institutions, of the 875 science student teachers, only 496 registered for teaching interviews with institutional job placement facilities, and only 325 accepted jobs in science teaching. In mathematics, there were 620 student teachers; 363 of these registered with a placement service, but only 269 accepted jobs as math teachers. (Data supplied by Dr. James Shymansky, the University of Iowa, Science Education Center, Ames, Iowa.)

Or, perhaps the following representative but hard facts will have more meaning:

In New Hampshire, only one 1982 college graduate expressed a desire to enter into a career as a mathematics teacher.

In New York, our second-most populous state, only 32 college graduates plan on teaching junior or senior high school mathematics. New York had well over one million students in these grades in 1979.

In Texas in 1982, only 7 of 20 mathematics teacher graduates entered teaching. (Data from the National Council of Teachers of Mathematics.)

While these figures may look bad, the actual situation is even worse. Data from a 1981 national survey of 1,000 school administrators indicates that one out of every two new people hired to teach math and science courses do not hold the appropriate credentials to teach these courses. This fifty percent figure is the national average; when you look at the figures by region, the range is from 9 percent in the northeast states to 84 percent in the Pacific coast states, which is, of course, the region where so much of our high technology industry is concentrated. (Data supplied by Dr. James Shymansky, University of Iowa, Science Education Center, Ames, Iowa.)

In addition to our present shortage, we can expect even more calamitous shortages in the future as two serious demographic trends begin to interact to exacerbate the present situation. One trend is teacher age; the other is school enrollment. In general, due to retrenchment and drain-off by industry, the present teacher supply is graying rather rapidly. Math and science teachers, on average, have about 16–18 years of teaching experience, and consequently will begin retiring over the course of the next decade and-a-half—but more as a group than as individuals, since many are of the same age. At the same time, while school enrollments are currently declining, they are expected to climb again for a while in the 1990s, and this climb in school enrollments will parallel the large-scale retirements of math and science teachers (Gutherie & Zusman, 1983). Thus, in the next 15 to 20 years, the crisis in math and science could reach catastrophic proportions.

American may soon have to import large numbers of foreign teachers to instruct students in math and science if the situation described above is not quickly remedied. Such a solution has already been suggested by a member of the Southern Regional Education Board's Task Force on Higher Education (June, 1982).

In tandem with the decline in availability of qualified math and science teachers, student achievement in these areas has fallen drastically over the last decade. Students' performance on the Scholastic Aptitude Test is one index: verbal performance scores have dropped 49 points since 1965, and math scores have dropped 30 points. Similarly, math and science performance data from the National Assessment of Educational Progress indicates significant decreases in both areas over the years 1973 to 1978. Such performance decrements as these were once attributed to increasing numbers of women and minorities taking the tests. However, more recent data indicates that the declines are evident even among the best white male students, supporting a view that a decrease in quality of performance has occurred, not just a change in the population being tested. The following graphs illustrate these performance declines:

In addition to standardized test performance decrements, there are other indexes of a decline in the quality of our students' math and science achievement. For example, there has been a significant increase in the number of students taking remedial courses at our nation's colleges, as illustrated in graph 3.

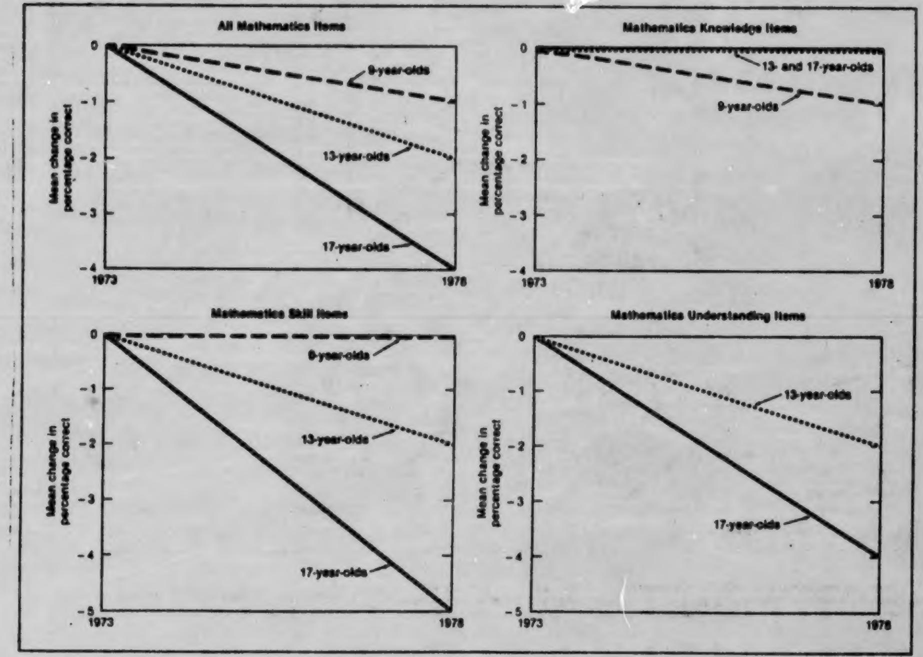
It is not enough to be concerned only about the crisis in math and science education with respect to the quality of education our students are receiving. While one goal of Education is to acquire knowledge, an equally important goal is to apply knowledge toward the enhancement of one's own well-being as well as the enhancement of the nation's well-being. That is, an education should help the individual better him- or herself and at the same time contribute to the collective national good. In this sense, Education is inextricably bound up in the nation's economy.

As long as our economy was characterized by large labor forces, by reliance on heavy manufacturing, and by little foreign competition, the direct relationship that exists between education and the economy was masked by continual increases in our Gross National Product. As we all are becoming increasingly aware, however, our economy is undergoing some major structural changes, caused by a decreasing need for large labor forces, for heavy manufacturing, and from increasing foreign competitiveness. Consequently, the importance of the quality and content of education to economic productivity is now becoming readily apparent. And, while this is true with all areas of eduction, it is especially true with respect to math and science education because these two content areas provide the foundation for our rapidly developing high-technology-based economy.

Figure 1

Changes in mathematical achievement, 1973-78, for 9-, 13-, and 17-year-olds: National Assessment of Educational Progress

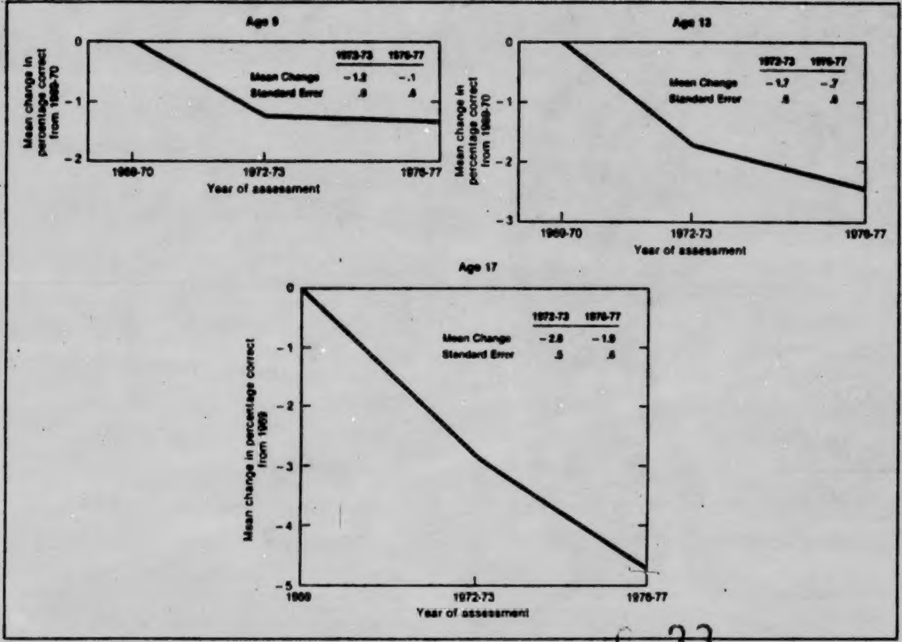
Overall mathematics achievement declined for all three age groups with the decline for the two older groups being statistically significant at the .05 level, with the exception of the knowledge items. Where there were no statistically significant differences, the older the group the steeper the decline in each of the assessed areas.



[illegible]

Changes in science achievement for 9-, 13- and 17-year olds: 1969-77

Overall achievement in science declined for all age groups at every test interval. All three declines in the first National Assessment and Educational Progress NAEP Testing interval were statistically significant (at the .05 level) while only that for 17-year-olds was significant in the second interval.

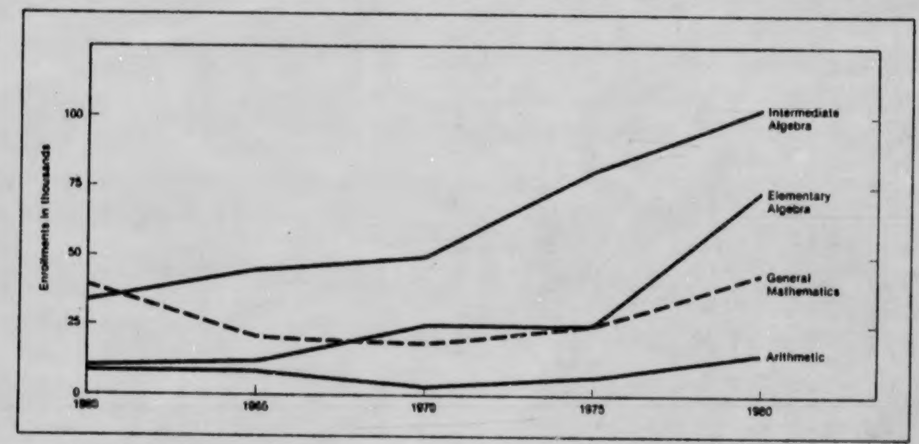


Source: National Assessment of Educational Progress, *Three National Assessments of Science: Changes in Achievement, 1969-77*, p. 6.

Figure 3

Remedial mathematics in universities and four-year colleges

Since 1960, enrollment in remedial arithmetic, general mathematics, and algebra has increased by 165%. Those courses now constitute 18% of all mathematics enrollments, compared to 13% in 1960. The biggest increase occurred between 1975 and 1980, matching a period of widespread reports that high school preparation in mathematics has declined sharply.



Source: Undergraduate Mathematical Sciences in Universities, Four-Year Colleges, and Two-Year Colleges, 1980-1981. James T. Fey and Wendell H. Fleming. Conference Board on Mathematical Sciences, 1981.

Data from two divergent sources indicate the impact of poorly trained employees on productivity, quality control and consumer costs. AT&T now spends $6 million a year to train 14,000 employees in basic arithmetic and writing during office hours (U.S. Chamber of Commerce, 1982) and a survey of over 2,000 corporations, published in December, 1982, revealed that mathematics was consistently noted as a deficient skill across a wide range of job classifications (Henry & Raymond, 1982). Given that the nine most rapidly growing industries in our economy are high-technology and energy-related industries, all requiring math and science backgrounds, continued reliance on employees with poor educational backgrounds will not only likely increase consumer costs significantly but, more importantly, will likely accelerate the United States' already-eroding competitive economic position.

Lest my words sound like mere rhetoric, consider the case of our neighbor, Japan. Once characterized by a lack of valuable minerals, arable land, and financial resources, Japan today is in direct competition with the United States. Japan's rapid economic gains have enabled here to surpass the United States in a number of areas: her per capita income is greater than ours. Currently about five times as many Japanese as Americans and Western Europeans reach superior levels of intelligence, due in large part, experts say, to rapid and positive changes in Japan's social environments, family circumstances, education, health, and investments in human capital (Lynn, 1982). Furthermore, Japan issues more patents and publishes more novels than any other country, and the quality of her manufactured goods is among the best (Vogel, 1978).

Some of the reasons for this may be related to differences in how well Japanese children are educated, especially in the math and science areas.

Japanese 13-year-olds have the highest achievement scores among 12 major industrialized countries, including the United States.

One-fourth of all class time in grades 7–9 is spent on math and science content.

Japanese high school students normally take 3 natural science courses and 4 math courses.

Only 8 percent of Japanese students fail to graduate from high school.

Whereas, in the United States:

Only one-third of our school districts require more than one year of math and science to graduate.

Of all high school students in the United States, half take no math after 10th grade and only one tenth or eleventh grader in six takes a science course and only one in 14 takes a physics course.

One-fourth of all high school students fail to graduate.

Furthermore, in the Soviet Union, five million secondary school students enroll in a two-year calculus course; but in the United States, only about 500,000 high school students take a one-year course in calculus. All Soviet students complete 5 years of physics, 4 years of chemistry, and up to 4 years of biology before they complete high school, and their school drop-out rate is only 2 percent.

One additional fact is worth pointing out about these data: while our good students will stand up to comparison with any of our competitors, the Japanese and the Soviets are training in higher levels of average functioning—many more of their youth are average or better in math and science skills than are our youths.

There are likely many lessons to be learned from these data and other data that you will be receiving during the course of these hearings. I would like to reinforce two major themes that I think run through all that I know about the extent of our problem: first, we face a serious math and science teacher shortage that is not going to get better on its own. We must take some action to stem depletion of one of our most important educational and economic resources. Second, our economy is shifting from one based in heavy manufacturing to one based in high technology; and to retain our position in the international high-technology marketplace, we must have workers who are well-trained in math and science skills. It's very simple: our way of life depends on it.

I think the approaches outlined in the Emergency Mathematics and Science Education Act will go a long way towards insuring a resolution of the crisis we face. H.R. 30 represents a good beginning and one that we must follow up with subsequent legislation to provide for a well-trained cadre of high-technology technicians, to expand our suppport of basic scientific and technical research to further solidify the relationship between math and science education and economic development; and I think we need to take steps to insure that the general public is aware of the critical role played by math and science in our everyday lives. All of these are issues that I hope this Committee and the Congress will address immediately, to end this crisis.

Chairman **Perkins**. Mr. Boucher.

Mr. **Boucher**. Mr. Chairman, it is an honor for me to serve as a member of this committee and as a member of the Subcommittee on Elementary, Secondary, and Vocational Education. We represent adjoining districts. Our constituents have similar concerns and similar hopes. Our commonality of interests was a major reason I sought assignment to this committee.

As you know, southwest Virginia is in need of jobs. In some counties in my district, unemployment is well above 20 percent. For the men and women without work there is nothing more important than finding a job and having an income to provide for their families. In the longer term, our challenge is to provide education and training so that workers in coal and other basic industries can keep pace with technology and so that young people who are graduated from high school are prepared for the demands of a modern job market.

That brings us to H.R. 30, the subject of today's hearing. This legislation is appropriately named the Emergency Mathematics and Science Education Act, for we do indeed face an emergency. H.R. 30 may become as important in the 1980s as was the National Defense Education Act in the 1960s. In Japan last year, twice the number of electronics engineers received advanced degrees than were graduated in the United States, and yet Japan has less than one-half our population. Technical education standards in the Soviet Union are higher than those in this country. The need for a renewed emphasis on teacher training and on scientific and math education is urgent because of a demonstrated and sustained shortage of well-qualified math and science teachers.

I look forward to hearing witnesses comment on the administrative aspects of H.R. 30 and how we can get the greatest good for the dollar in this important program. In the meantime, Mr. Chairman, let me reiterate my appreciation for the courtesies you have shown and for the leadership you have demonstrated on this vital issue before the committee.

Chairman **Perkins**. Thank you.

Mr. Bartlett, do you want to say anything?

Mr. **Bartlett**. Not at this time.

Chairman **Perkins**. Mr. Gunderson, anybody?

Go ahead, Don. We welcome you here again.

STATEMENT OF HON. DON FUQUA, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF FLORIDA

Mr. **Fuqua**. Thank you, Mr. Chairman. It is a pleasure to be here before the Education and Labor Committee. I observe that our committees are going to have a certain amount of interlocking this year. I notice the gentleman from Virginia is also a member of our committee. We have also been pleased to have Mr. Simon join our committee this year. So we think we will have a close working relationship with the Education and Labor Committee, as we have tried to have over the years. I believe that both the Committee on Science and Technology and the Committee on Education and Labor recognize the importance of this issue to the Nation's long-term economic health and well-being.

Mr. Chairman, you are also to be congratulated for moving so quickly and holding these very important hearings. I am sure that over the next 5 days of hearings that you will receive numerous facts concerning the extent of the crisis in education. I do not intend to dwell on the details of that crisis, but let me simply note a few facts that stand out from the extensive set of hearings on this matter held before the Committee on Science and Technology:

Fifty percent of the new science and math teachers at the secondary school level are not certified to teach in those subjects.

Less than 30 percent of the Nation's high schools require more than one year of science and math.

We currently have a 9-percent shortage in engineering faculty just at the time when engineering course enrollments are increasing substantially.

Overcrowding of classrooms, lack of advanced instructional and research instrumentation, as well as noncompetitive salaries are attracting young engineering faculty out of the university and into industry.

Fewer American engineering students are entering graduate-level programs to create the next generation of teachers and researchers in this very important area.

Mr. Chairman, as you have already noted, the problems are quite extensive, underscoring the need for quick action. In the 97th Congress over 40 pieces of similar-type legislation were introduced. Although no final action took place, I believe that most members who have been most aware and have studied this problem are now prepared to act. Recently I introduced along with our colleague, Congressman Walgren, and others, H.R. 582, the National Engineering and Science Personnel Act of 1983. As now proposed, this bill considerably streamlines the legislation reported by our committee last year and provides for a strong statement of policy and commitment by the Federal Government to maintain the quality and quantity of necessary technical, engineering and scientific personnel. It further provides a special matching fund operated through the National Science Foundation to leverage important private sector moneys into programs to be designed for eliminating the crisis in science and engineering education. The fund would be authorized for $100 million per year for 5 years.

H.R. 582 is not intended to be a single answer—the so-called silver bullet—to the complex issue now confronting us. Rather it is intended to be a beginning step together with other beginning steps such as H.R. 30, the Emergency Mathematics and Science Education Act, which you are considering today.

H.R. 30 focuses on the role of the Department of Education, as the Department must assume the major Federal role in assuring the overall quality of education in this country. I also believe that there is a role to be played by the National Science Foundation. The Foundation is mandated in its national charter to maintain the health of science engineering education. The Foundation is also in a position to best use the scientific and engineering expertise available to the Nation to focus on the special problems and needs of science, math, and engineering education personnel. Thus I would hope that the efforts of both of our committees, Mr. Chairman, would be brought to bear in a coordinated and a collaborative manner to find the best means of resolving this crisis in education.

I look forward to working further with you and your committee in working cooperatively to see that the Federal Government takes the lead in solving our national problem in science and engineering education and personnel.

Chairman PERKINS. Go ahead, Mr. Goodling.

Mr. GOODLING. Mr. Chairman, I just want to say, Mr. Chairman, that one of the things that we are going to have to do, as we work together on this situation, is to deal with is the fact that there probably is not a shortage of trained math and science teachers in this country. The problem is that they are not in teaching. We are first going to have to deal with the problem of how you get them in to teaching after they are trained, and, second, not lose so many good ones to the private sector. That is going to happen more and more as we get into this high-technology area. We need to be concerned about how we are going to keep them in the teaching profession. Both committees have to look at that issue.

Mr. FUQUA. I think the gentleman outlines it accurately. Also we are having a problem with the number of people at college level that are going into postgraduate degrees that will be the wellspring of new information and ideas as we go into the 21st century. Fewer and fewer are going into teaching and research to teach others as the stream comes along. This is of a great deal of concern, and of course many of them are attracted into industry and are not staying in the colleges or not even going on and getting master's and Ph. D. degrees. This is a question that we are addressing in our bill of H.R. 582. But I think the two bills, H.R. 30 and the bill that myself and Mr. Walgren have introduced, parallel each other, and work together, and I think can be coordinated to a very successful, more comprehensive program.

Chairman PERKINS. Don, after Sputnik went up in 1958, we wrote the National Defense Education Act. The primary emphasis at that time was on science and mathematics. And it worked well for several years. Then we commenced to broaden the National Defense Education Act to cover the whole waterfront and to a degree we let science and mathematics slide to a back burner.

But at the same time, as Mr. Goodling pointed out, industry was siphoning off our best math teachers. And that is the situation today.

As Mr. Goodling pointed out, at a time when we are cutting our budgets back throughout the Nation at the State and Federal levels, how are we going to keep these teachers in the classroom instead of letting private industry pick them off with maybe a doubling of their salaries?

This is one of the problems that we have got to nail down in this bill some way. What are your views along that line?

Mr. FUQUA. Mr. Chairman, the National Defense Education Act worked well. It started after Sputnik went up in 1958. One of the things that you pointed out is the funding for it began to be reduced year after year. Some of the programs were very successful, such as the program of bringing teachers in for the summer, either industry employed them in their laboratories or they came in for workshops at the various universities to improve and upgrade their teaching skills and learn new methods and make science more interesting to students in school.

I pointed out in my testimony the vast amount of schools that do not even offer more than just one year of science and math. Over 50 percent of the students never take a course in math, science, chemistry or those type classes after the 10th grade. That is a fundamental problem that must be addressed at the local level and I think concerned parents, school boards and school administrators are recognizing that problem today.

I think if we can encourage industry to hire people for the summer, we can get around the pay differential. We do have a problem if you try to pay one group of teachers more than another.

Nobody probably is more aware of that than the gentleman from Pennsylvania, Mr. Goodling, who has been in that profession. But that is one of the ways we can attract teachers, because they would be on a 12-month contract rather than a 9- or 10-month contract as many others are on.

I have talked to a number of teachers that are very supportive of this type of effort.

Chairman PERKINS. Now, if I understand the bill that you have introduced, the training bill, it charges the National Science Foundation to improve high-level scientific technician and engineering training. Now, the bill, H.R. 30, deals with the need for a broad level of science and math education for all students and not just the highly trained or educated.

Do you see any conflict between these bills or do they complement each other?

Mr. FUQUA. As I mentioned earlier, I think the two bills complement each other. H.R. 582 does not include technical training, but it is primarily aimed at trying to improve—as contained in the charter of the National Science Foundation—science education. This would include teachers and colleges that would be able to offer fellowships, money for improving laboratory technicians, and a provision for matching funds.

The other half of the funds must come from private industry or State and local funds. I have talked with private industry; the American Council on Education that is made up of a lot of business and academic people. They are very supportive of this type of approach.

Business is willing to match these funds. And they are very concerned about the future manpower needs of this country. So to answer your question, I think both bills complement each other and make a more rounded package than either one of them separately would.

Chairman PERKINS. Mr. Biaggi.

Mr. BIAGGI. Thank you, Mr. Chairman. I thank my colleague for his concern and also his action in connection with this issue. I contemplate a scenario that could bring us into a troublesome situation further down the line.

I would like to propose it to you for your reaction. Is my understanding correct that your bill would give special incentives for teachers to embark upon careers in science and mathematics and would those incentives come in the form of salary differentials?

Mr. **Fuqua**. It would not provide a salary differential. It would provide an opportunity to have summer training and get paid for it. They would be offered a fellowship for a master's degree or postbaccalaureate degree. It would provide stipends for graduate students to continue on ultimately to their Ph. D. degree in these critical fields.

It would provide money for instrumentation and equipment that could be used in labratories so students could have a better opportunity of training than they are getting in some labs. The equipment is very old and dilapidated and the labs need new equipment. Most industrial labs are much better equipped than say at a university laboratory.

Mr. **Biaggi**. Substantially better.

Mr. **Fuqua**. Yes.

Mr. **Biaggi**. Mr. Chairman, you made reference to an early effort on the part of Congress in 1958 that was successful to a degree, but then it somehow waned over the years. What assurance do we have or what can we do as a committee to prevent that from recurring? Obviously this is not a short-term crisis. It is an issue that will be with us for a considerable period of time.

Chairman **Perkins**. Are you through?

Mr. **Biaggi**. I posed a question.

Chairman **Perkins**. What assurance do we have that the same thing wouldn't happen with this legislation, if I understand you correctly.

Mr. **Biaggi**. That is the problem.

Chairman **Perkins**. I think we have to set up more safeguards in the legislation, and not let these grants go to teachers that are going to desert us in a period of 2 or 3 years. I think we have got to give more protection to the schools to make sure that we have these teachers available after we train them.

We know that industry will continue to offer higher salaries, and it is natural if we leave any loopholes for these youngsters just to leave the schools and go for a better standard of living. We have got to accept reality and try to combat those things.

Mrs. Roukema, go right ahead.

Mrs. **Roukema**. Thank you, Mr. Chairman.

Congressman, I am very interested in your legislation and of course the subject highlights a very critical and imminent problem that we have. I wonder, since we have had the experience and we can anticipate yet another problem down the line with a continuing supply of well-trained teachers as has already been alluded to by the previous panel members, did you in your committee give any thought to going beyond the matching fund requirement with business and search for any other cooperative partnership effort in terms of maintaining the high quality teaching staff?

Now, admittedly it would be a difficult problem to resolve, but my mind has gone to the idea of a flexible time program and an interchange perhaps with members of the business community who actually come in and teach and supplement the program. Have you explored that at all or has it ever been explored by the National Science Foundation?

Mr. **Fuqua**. We first of all limit the bill to 5 years, so that it sunsets at that time, and we must review the program and what has happened. We say the money must be matched by either private or local funds. If the States, foundations, or industry want to put up funds, it must be matched by some funds.

There are ways that you can encumber the bill so much. We have tried not to go beyond the scope of the jurisdiction of the Committee on Science and Technology, which has sole jurisdiction over the National Science Foundation. In its charter NSF is charged with promoting science education.

Now, science education can be a fuzzy area sometimes. But what is basically intended is that teachers are prepared in a manner so that they can have the ability to teach at the best levels.

Also, what is the manpower of science and education, science-education? Most all the basic research in this country is carried on in the universities and colleges. Applied research is carried on in industrial labs, but the basic theoretical research is carried on in universities. We must recharge that stream since the average age of university researchers today is increasing chronologically every year and the new ones are not coming in because of the attraction of industry right now and the job requirements.

So we are trying to encourage but not like we did in the sixties where we offered everybody that wanted to be an engineer a scholarship. We are not proposing that since that created an oversupply and we had engineers running elevators and driving taxis. We are not trying to approach that.

We are not really aiming for the baccalaureate degree. A person gets that on their own. We are trying to get the person that is interested in going into research with encouragement to do that with a small stipend in the form of a fellowship so he or she can get his master's and Ph. D. degree and possibly stay in research in the university.

Mrs. **Roukema**. I concur with that. Perhaps I misunderstood the scope of your legislation. I thought there was a portion of it that was directed to the classroom teacher.

Mr. **Fuqua**. I think this is H.R. 30 that would direct itself more to that.

Mrs. **Roukema**. With that in mind, based on your experience, because you have dealt a lot with the private sector, do you see any possibility of a coordinated effort here? Because let's face it, the problem that we are all grappling with is the fact that we can never be competitive in public education on the salary level.

How can we supplement?

Mr. **Fuqua**. Well, Congressman McCurdy and Senator Glenn have a bill that addresses somewhat that issue in providing tax credits for industry if they hire science teachers to work in the summertime in their labs. Now, that is a different issue.

Mrs. **Roukema**. That borders on what I am talking about.

Mr. **Fuqua**. That complements the overall issue we are talking about.

Mrs. **Roukema**. Thank you. Very interesting.

Chairman **Perkins**. Mr. Williams.

Mr. **Williams**. Thank you, Mr. Chairman.

Chairman Fuqua, I appreciate the directness of your statement and particularly commend you for being forthright in your belief that the National Science Foundation as you have put it in your statement, has a role to play in the legislation. I am hopeful that the differences in the two pieces of legislation with regard to that point will not delay this from being enacted into law.

Mr. **Fuqua**. I concur.

Mr. **Williams**. I agree that we should be able to develop a final piece of legislation that finds that the Department of Education and the National Institutes of Education can consult with appropriate Federal agencies, including absolutely the National Science Foundation, in a coordinated approach to this problem, but with all appropriate respect, I would say to the two distinguished chairmen in the hearing room today that this crisis is too great and the problem is too immediate to permit us to delay this legislation because of squabbles over turf. We really have to get on with this bill and with your bill.

Mr. **Fuqua**. The only turf problem that the chairman and I have is over whether racehorses are better in Kentucky or Florida, and I yield to him.

Mr. **Williams**. Thank you, Mr. Chairman.

Chairman **Perkins**. Mr. Bartlett from Texas, a new member.

Mr. **Bartlett**. Thank you, Mr. Chairman.

Mr. Fuqua, I am too new on this committee to know anything about the turf battles or such as that.

Mr. **Fuqua**. Well, you will learn.

Mr. **Bartlett**. I hope so. I have a couple of questions on the budget impact. What is the budget impact of H.R. 582?

Mr. **Fuqua**. This proposes to authorize $100 million a year for 5 years.

Mr. **Bartlett**. Per year.

Mr. **Fuqua**. To be matched by private or other funds.

Mr. **Bartlett**. And each grant would be matched by someone?

Mr. **Fuqua**. That is correct.

Mr. **Bartlett**. What percentage of that budget would be actually delivered to a classroom teacher?

Mr. **Fuqua**. Probably—as I was outlining earlier, it is not broken down to how much is going to a classroom teacher. There would be some provided since we leave this flexibility up to the National Science Foundation to administer the program. We don't say we want 10 percent or 15 percent to go to classroom teachers. The only benefit the classroom teachers would receive would be through summer workshops, where they would be paid to attend and improve and modernize their skills in math and science. They would be remunerated for that.

The other part would go to fellowships, capital equipment, salaries, instrumentation and other activities as are considered necessary in carrying out the purposes of this Act. And we purposely did that to give rather broad authority to the National Science Foundation rather than set up a rigid mechanism.

They must report to Congress. We must ride herd over it and make sure we feel the program is operating in a successful fashion. One of the programs for high school teachers would be these summer workshops that originated, with Congressman Perkins and others in the National Defense Education Act in the early Sixties.

Mr. **Bartlett**. So with the exception of summer workshops, none of the $100 million a year would actually go to classroom teachers to teach math and science?

Mr. **Fuqua**. It would not. Not as a supplement to their regular salary.

Mr. **Bartlett**. Is there any additional type of formula allocation or is the money to be spent by the National Science Foundation in any state or in any way or in any location. None of it would necessarily come to Farmers Branch, Texas or to Pennsylvania?

Mr. **Fuqua**. We hope it would go to those schools and universities that were worthy, particularly those with graduate programs. This is mainly aimed at graduate programs.

So as a consequence it would probably not go to a community college, even though there may be a workshop held at a community college for the summer science program for teachers.

Mr. **Bartlett**. Each grant would be by application?

Mr. **Fuqua**. They would probably grant a school in Texas—the University of Texas, Baylor, Rice, or any other fine school—that makes an application. The school would state that so many people wanted to apply who are qualified in the field and NSF would determine how much they could grant.

If a school had 100, 45 would be an equitable distribution to try to get it spread around the country. I would hope this wouldn't all go to the elitist schools, but also to the schools generally spread geographically all around the country.

Mr. **Bartlett**. Thank you, Congressman.

Chairman **Perkins**. Mr. Boucher.

Mr. **Boucher**. I will pass, Mr. Chairman.

Chairman **Perkins**. Let me ask you a question in connection, Mr. Chairman. Your bill, if I understand it correctly, requires matching for some of the programs. Florida as well as Kentucky and many other States are having severe budgetary problems at the present time.

I know down home they are cutting back. In one county in my district, I learned only this week, the county east of the Mississippi River back down in Kentucky, they were laying off 163 teacher aides under the title I program because of the cutback in Federal funds.

In view of the economic plight throughout the country, do you think these States like my State and numerous other States will come up with the matching funds? I just want to ask you that question.

Mr. **Fuqua**. Well, it was not intended that it solely had to be the State or local governments that provide the matching funds. It was primarily aimed at industry. But if a State felt that this had a high enough priority, and they could provide those funds, we would not want to prohibit that from happening.

We have some States, as the gentleman is well aware, that are better off financially than other States or have different sources of funds. For instance, the University of Texas has a rather good endowment granted to it by the State of Texas, which is now producing rather well.

This would not preclude a school such as that from matching funds or the State or local governments. But, it was primarily intended that these matching funds come from private industry.

Chairman PERKINS. I know that, but in times like these when you have unemployment in so many of our industries for example in Louisville, International Harvester and several big corporations are folding up—I am just wondering here if we won't have a stumbling block in this matching requirement.

If 15 or 20 of the states needed this money and could not come up with the matching funds, that is one thing I think you and I and all the other members should give greater consideration to.

Mr. FUQUA. Mr. Chairman, you raise a very interesting point. But I think while industry is shifting in emphasis, I think you are going to find that there are many industries in this country that are thriving rather well right now, particularly in the high technology field.

These are the people that need the engineers and the scientists to make sure that their stream of new blood, new ideas, and new brainpower continue uninterrupted. Those companies would be very interested in trying to support H.R. 582.—As a matter of fact, I have talked to many of them and they are very supportive of this approach and feel their industries could come up with the matching funds.

Chairman PERKINS. Now, last year for the National Science Foundation the Congress appropriated $15 million more than the President wanted. And the National Science Foundation now proposes to use this money for teacher training programs at universities. And the universities which will have received these funds will have to serve a very well-known and recognized faculty. Now, I am concerned that this is too elitist and could not help the majority of teachers.

Do you have this concern about the National Science Foundation? I have watched them over a period of years since we have created that organization in 1949, the Education and Labor Committee.

Mr. FUQUA. Well, Mr. Chairman, of course the National Science Foundation has a policy that all of the proposals submitted to them are reviewed on a peer review basis. They have panels that review on a professional basis and try to award those grants to where they think that the Government and the taxpayer can get the best research and the best results. That does not always mean that a university in my district or in your district is always going to receive those funds. But we have also had a program, some institutional block grants and others, to improve certain facets of the various universities around the country for several years that was very helpful. Many of the universities have improved their ability to do research. Not all universities have a strong graduate program and a research program.

Then we have some of the funding for large projects. at some of the bigger schools, They started early and have some big projects that are funded on a yearly basis, maybe in say a nuclear accelerator program or something of that type that is very expensive. When you look at their figures, it comes out somewhat distorted compared to what other schools received. But they do have a peer review program, try to do it on a professional and not a political basis, and that is the way it should be done.

There are always ways to improve that. We have had language in our bill to encourage a better geographical distribution of the funding within the National Science Foundation, so that we can strengthen the universities and colleges all over this country and not just a few. We can try to improve the educational opportunities all over this country. If you look at that you will see they have done a pretty good job under the system of trying to get the best research for the dollar.

Chairman PERKINS. I would agree with you in many instances they have done a wonderful job. In some instances I thought the job was not up to the caliber it should have been.

Mr. FUQUA. They have constantly tried to improve their procedures.

Chairman PERKINS. In some instances they had a buddy-buddy relation. I know you are well aware of that, as I am.

Mr. FUQUA. Yes.

Chairman PERKINS. Let me congratulate you this morning for your appearance here, and your excellent testimony. I think you have done a very good thing in coming here and testifying. There is no reason in the world why you and I cannot work together, as the chairmen of the two committees. We will work together.

We want to do what is best for the country, what is best to bring about a good science and mathematics program in the elementary and secondary schools of the nation, and in higher education institutions. But we have to get something started in the elementary and secondary schools. We will do everything possible to never let America slide backward, but from a scientific viewpoint keep America on top.

Thank you for coming this morning.

Mr. FUQUA. Thank you, Mr. Chairman.

As Mr. Williams pointed out, we have a serious situation. It is certainly not my intention and I am sure not yours, to let petty things happen that would prevent something as important as this is to our Nation and our future, to impede the progress of these pieces of legislation that I think are very, very important.

I thank you for your courtesy.

Chairman PERKINS. Thank you very much. Now I understand we have the chairman of your subcommittee here, Mr. Doug Walgren from Pennsylvania.

Glad to welcome you here this morning.

STATEMENT OF HON. DOUG WALGREN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF PENNSYLVANIA

Mr. WALGREN. Thank you very much, Mr. Chairman.

I would like to simply say that it is a great honor and I certainly appreciate the opportunity to come before your committee, along with the chairman of my full committee and others interested in this subject.

I hope, particularly after listening to the exchange between the chairman of the full Science and Technology Committee and the members of your committee, that we can look at the several institutions that are involved in this area and try to focus on their strengths. I think if we do that, we will see there is a role, as the chairman has said, for both the National Science Foundation and the Department of Education, and the other elements in our society, I honestly believe that this problem is so large and so pervasive that it is going to take every avenue available to us to solve the problem.

Any institution will have its limitations. And the trick, as we all know, is to take advantage of their strengths and avoid their weaknesses where possible. I think if we look at these institutions that the possibilities will become evident.

I know, for example, from my own point of view that the effort of the National Science Foundation was not to address the whole problem, or really not to solve the whole problem, but rather to provide some innovative and some individual instances where we would be doing the best that we could. I think the National Science Foundation has some specific strengths in its flexibility in that area. But when it comes to maintaining the breadth of a program and to maintaining the duration in time particularly, that is going to be a problem. As the Chairman and Mr. Biaggi pointed out we have to have formula proposals and programs that will run through time and run broadly. The National Science Foundation is probably not the agency to rely solely on for that.

I do think there are some very real strengths that NSF does have, particularly when you think of the fact that we have a crisis in which we are going to have to try to incorporate strengths that already exist in our society. As Mr. Goodling pointed out—the teachers are there, they are just not in the schools.

It seems to me that the National Science Foundation may have strengths in drawing participation from the private sector in a very flexible manner. Such participation can contribute to a particular area in a way that might take us longer to get up and running if we use a larger institution such as the Department of Education.

I don't know that is the proper differential, but I think if all the members that are involved in this area focus on the strengths of their institutions it would become evident where we can move forward.

I would like to say that this committee has a long and distinguished history of contributing significantly to American education at all levels.

I believe that this year is a year that has tremendous potential. There is clearly a broad bipartisan consensus across the land, and that consensus is, first, that we face a serious problem in math and science education, and second, that the Federal Government has a major role in providing effective solutions in this area.

It seems to me that we all should welcome the President's words on this problem last night and hope that it reflects a change of view of this administration. I remember last year when they proposed eliminating all funds for the science education programs under the National Science Foundation and serious cutbacks in education programs in other parts of the Government. So I feel that we should hope that it does reflect a real recognition on the part of this administration that a major initiative has to take place in this area.

Others, have outlined the crisis. Clearly our technical engineering and scientific skills must be substantially increased and broadened throughout our educational system. The specific comparisons between the graduates of Japan, the Soviet Union, and the United States leaves us far behind. And it is clearly a threat, not only to our economic future but to our military and defense capability as well.

So we must improve the training and education of teachers and upgrade curriculum at all levels. We have to find ways to keep the teachers in the schools and professors in the colleges so they are not lured away to the more lucrative careers in private industry. Clearly we must improve the equipment and technology that your students have present access to during their training. Much of that is woefully inadequate and outdated.

I was literally stunned to walk into a major university in Pennsylvania and find that every piece of equipment in the laboratory accessible to those students was World War II vintage cast off by the Defense Department in 1945 to 1947, except for two robots, both of which were contributed by a Japanese company out of the good will of their society towards ours.

Chairman **Perkins**. Since you are on this subject, how much emphasis do you think we should place on our hardware, on obtaining the most up-to-date equipment? How much emphasis on that?

Mr. **Walgren**. I personally don't have the background to form the proper judgment in my own experience. It is my understanding that this problem may be bigger than all of us. It clearly would be the kind of thing where broad-based funding should be brought into play because we are thinking of students across the board.

I think the Department of Education, as I understand the ability to institutionalize a program and to fund it with momentum, might really be the primary player in that role. On a stopgap level, we could try to get students out into private enterprise where there are some state-of-the-art computers and at least give them some contact with that equipment. It strikes me, again, the National Science Foundation may be the proper agency to involve the private sector in the short run.

But those are about the extent of my views on the subject, Mr. Chairman.

Mr. **Biaggi**. Mr. Chairman——

Chairman **Perkins**. Let me make one comment before you follow that up.

In 1966, it may have been the fiscal year 1967, we authorized the title I legislation, now called chapter 1. And we had these equipment salesmen all over the country at the State level. And through the people here in Washington and through the people at the local level, they bought so much equipment that was not utilized maybe for 2, 3 or 4 years. They threw away some of that money, and it was a shameful situation. But it was our fault, for not monitoring the situation more closely.

That is the only instance I know of anything like that occurring. But I would hate to leave it up to the National Science Foundation.

The National Science Foundation is constituted quite differently now from what it used to be. I don't know anything about the present members. They may be people that will not waste a dime in any way, shape or form. But I know they have all had their bad habits in the past, in years gone by. And unless you are in a position to find out about those things, you just don't know it. But I have had the experience and contact with it over a period of years.

Whoever has the authority should have some supervision over these funds, whether at the local educational agency level—maybe we could work out something where they could cooperate with the National Science Foundation. But we are going to have to have some technicians to talk to these teachers that teach the science and math at the local level.

It is a big problem just buying the equipment, keeping laboratories up-to-date.

Mr. Goodling.

Mr. GOODLING. Congressman Walgren, in your proposal where you talk about matching funds and, getting back to this issue of equipment, I have said for a long time there is no way most school districts or colleges or vocational education programs could possibly purchase the necessary equipment, if they are going to have up-to-date equipment, unless there is some kind of cooperative arrangement more than there is at the present time. However, in some areas there is a lot of cooperation and the private sector is involved.

Does your proposal, when you talk about matching funds and so on, does your proposal envision the equipment part of this partnership?

Mr. WALGREN. Absolutely. The matching component would be available for a number of different kinds of efforts, equipment being one of them.

It strikes me that we do want to involve the interest of the private sector in this particular area. Thinking of Pittsburgh and some of the identification that communities have with their local schools, there is real potential for private sector money to come forward to adequately equip a school with which that area identifies. So we would hope that in the equipment area in particular that some of this match would come from the private sector.

Also, in regard to the match we ought to think of where programs are best delivered from; some programs are best delivered from the grass roots, and other programs are best delivered from a national perspective. In the equipment area in particular, things are changing rapidly. This differs from level of education to level of education.

The equipment needs of the elementary and the secondary high school levels is very different than the equipment needs of a preparatory engineering exposure. We ought to try to have programs that are delivered at the local level, and I see room for programs that have broad availability.

Mr. GOODLING. We have to make sure that we don't get into competitive bids as the medical profession has for so many years. We are now at a point where we cannot afford to provide the same kind of equipment in every school. Even though two hospitals are only 2 miles apart, they both have to have the same kind of equipment, et cetera. We can't do that in education.

Chairman PERKINS. And another thing, if you will yield, Mr. Goodling, the computer industry could make contributions. In your

State, where the coal industry is on the rocks, and the steel industry is too, the railroad industry—and I would not know where to go to raise a quarter in my district at the present time. The rich districts will survive, but some of the poor districts won't get any contributions at all from private industry.

Mr. **Walgren**. My own feeling is that would be the case if that is the only approach we relied on. The only wisdom I have to offer, if it is wisdom at all, is that this problem is so big that we cannot take only one approach. I would not like to see us cut off the contribution that private sectors might be able to make in one part of the country, and perhaps not in another. Then if those areas are leaders we will then be able to take their example and add the strength to the demonstrated need in the areas of the country that don't have that.

If we were to say let's all go just this way, then my part of the country might very well be left out, and I would feel wronged by that. But it seems to me that the problem is large enough that there is room for multiple approaches.

Chairman **Perkins**. Let me ask you one more question.

I have seen figures that 85 percent of the National Science Foundation budget is going to research, including support of graduate students.

Mr. **Walgren**. That does comport with my understanding of the focus of their effort particularly in the science education program, where it was minimal at best. If I remember correctly, it was 7 percent of the National Science Foundation budget. We clearly have an agency here which is heavily involved in other activities. I do think it has a great deal to contribute in the area of science education, though.

Chairman **Perkins**. Go ahead, Mr. Biaggi.

Mr. **Biaggi**. Thank you, Mr. Chairman.

I thank my colleague for his contribution. I agree with you the issue is of sufficient magnitude to warrant the multifaceted approach.

With relation to the chairman's concern about massive expenditures of money, it is always subject to abuse. And frankly, the nature of the technology changes so quickly that vast expenditures of moneys could almost be called wasteful, because in short order the schools will be using equipment that is obsolete.

You make reference to some universities that have antediluvian equipment, and it is not uncommon in the educational facilities of America.

I recall, Mr. Chairman, a witness testifying some time ago on vocational training, where he testified that in his State, industries would provide equipment for the schools involved. That was the same equipment that the industries were using in the day-to-day operation. In effect, what they were doing was training the students to be proficient on these machines, so that when they graduated it was an easy transition into the job market, more specifically into those industries that provided the equipment.

It obviously has a self-serving purpose, but that is perfectly all right, too, because in the end it dealt with our primary concern, that is dealing with the issue of training people along certain avenues. And it might serve us well if we were to keep that in mind when we are thinking and drafting this legislation so that it would be universal application.

The chairman makes reference to the rich States where these high technical industries are located, and I think they would be pleased to make a contribution, because in the end they would be doing the same thing that this witness testified that his industry was doing, self-serving. But again, the chairman makes reference to the poorer States.

Well, in those poorer States, Mr. Chairman, we should be in a position to do something about it. But I don't think it would be a single approach. I don't think a single approach can do it. There should be multiple approaches, but with encouragement, special inducements, to get private industry involved and be current. That is clearly a criterion that must be built in somewhere.

If they are going to have equipment—I know this legislation provides for equipment—you have to be wary, because equipment can consume the money. I know it happened in the National Science. But if you are going to purchase equipment, you must work some arrangement so that the equipment is current. And that can be worked out somehow, but it must be worked out if the program is to have any meaning whatsoever.

Chairman PERKINS. Mrs. Roukema.

Mrs. ROUKEMA. Thank you, I have no questions.

I appreciate your testimony.

Chairman PERKINS. Mr. Weiss.

Mr. WEISS. Thank you, Mr. Chairman.

First, let me commend you, Congressman Walgren, and the members of your committee, for the leaderhsip which you have taken in focusing attention on what truly is a major national crisis.

You know, one of the problems that we have in the Congress is that issues tend to get very, very fragmented and the atttention given to them also gets to be fragmented. Perhaps what we ought to be doing is taking the benefit of the experience of people in the various committees whose work impacts to some extent on the particular concerns that we have in this area, but then try in some fashion to funnel the solutions or to get the solutions through a single source or single committee.

My sense is that Ways and Means, for example, is always going to have to get involved because of tax concerns, if we are talking about providing private sector involvement on the basis of tax benefits. But there is no reason why, for example, approaches which Ways and Means would undertake would not first pass through the Education and Labor Committee for substantive signoff. My sense is that a lot of the problems which seem to be real problems are only demonstrations of the fragmentation that we suffer from. And I am not sure that we might not somewhere along the line find that we can move together much more rapidly.

If we became aware of the fact that although the solutions ought to be coming from various sources, the ultimate resolution of those ought to come through a central area, then I think perhaps we would eliminate the concern as to whether it should be the National Science Foundation, Department of Education, or what have you, because all of it would be part of a comprehensive kind of effort.

I want to commend your role in highlighting the need for urgent attention. The problem we have to grapple with is both substantive and procedural: How do we get as urgent an action as possible out of this body?

Thank you, Mr. Chairman.

Chairman **PERKINS**. All right.

Mr. Erlenborn, any questions?

Mr. **ERLENBORN**. No questions.

Chairman **PERKINS**. Mr. Bartlett, any questions?

Mr. **BARTLETT**. No questions.

Mr. **WALGREN**. Mr. Chairman, if I might, in conclusion I feel that I ought to note in response to your highlighting and pointing out the problem of the old-boy network among the scientific community and the apprehension we have that funds may not be targeted in the most effective fashion, and that certain research agencies become elitists.

The problem of working against waste in that area is not limited to the National Science Foundation. Before coming to Congress I worked with a corporation that sold educational materials, largely to agencies using Federal funds. I was struck by the difficulty of overcoming the political relationships that were involved in the sale of materials to local school systems. This is a problem that is not just in any one agency in Government, but I am afraid it is widespread in Government activity, and one that is going to just take ultimate vigilance to minimize as best we can. It cannot be directed at any one agency as a greater problem than elsewhere.

Chairman **PERKINS**. Well, now, since 1949, since the enactment of the National Science Foundation program, and all through the years, if you will look at the debates that have taken place on the floor of the House and on the Senate floor, you will find that the real role of the National Science Foundation is to encourage high level research in science, and won't it be inappropriate for us to ask them to deal with science and math education of the general student population since we have set the National Science Foundation up for another purpose? That is the question.

Mr. **WALGREN**. The charter of the National Science Foundation does clearly set out a responsibility in the agency for the State and the quality of science education at all levels.

Now, that does not mean that that agency is the right one to implement all the programs.

Chairman **PERKINS**. Well, the real purpose of the establishment of the National Science Foundation, if you go back and read the record, the debate in 1949, was to encourage high level research in science. We wanted to keep ahead of the Russians. We had the cold war on at that time, and we were having our disputes with Russia.

The arguments were that we wanted to be the leader of the free world. And it was high level research, and not just down-to-earth problems that we deal with in high schools and even in the grade schools, or the foundation would never have been established in the first place.

Mr. **WALGREN**. Well, in closing—I apologize for having gone on longer——

Chairman **PERKINS**. Let me ask you to go back and read the purposes of the National Science Foundation when it was established.

Mr. **WALGREN**. I think we ought to take the present crisis that confronts us, and every institution in our society that can make a contribution, evaluate the strengths and the weaknesses of those institutions and try to put together the broadest possible program that we can. If we do that, I think that we will be able to look back on the 98th Congress and say it made the greatest contribution to the problem we face.

Chairman **PERKINS**. Thank you. You have made a good witness.

Mr. **WALGREN**. Thank you, Mr. Chairman, I have enjoyed it.

[Prepared statement of Congressman Doug Walgren follows:]

PREPARED STATEMENT OF HON. DOUG WALGREN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF PENNSYLVANIA

Thank you for this opportunity to present my views on our country's needs in science and math education to the Committee on Education and Labor. This committee has a long and distinguished history of contributing significantly to American education at all levels and of providing educational opportunities to all our children and citizens.

I believe there is a broad, bipartisan consensus across the land—first, that we face a serious problem in math and science education; and second, that the Federal Government has a major role in providing effective solutions in this area. I welcome President Reagan's words on this problem last night and hope that it reflects a change of view from an administration which last year proposed eliminating all funds from science education programs under the National Science Foundation.

Others have outlined the problem to you in great detail. Our technical, engineering, and scientific skills must be substantially increased and broadened.

The-thirds of all American high schools require only one year of science and math. In Japan, all college-bound high school students take four years of math and three years of science.

In the Soviet Union, high school students take five years of physics and four years of chemistry. In Russia, five million high school students take calculus. In the United States, only 500,000 high school students ever take this same math course.

The Soviets graduate twice as many scientists and five times as many engineers as American universities. America's inability to compete with these skills is as real a threat to our future as the Soviet military.

We must improve the training and education of teachers and upgrade curriculum at all levels. We have to find ways to keep teachers in schools and professors in colleges, so they are not lured to more lucrative careers in private industry. We must improve equipment and technology used to instruct our students.

Much of the equipment used to teach our students is woefully outdated and inadequate. I was literally stunned to walk into the engineering laboratory of a major Pennsylvania University to find that all the equipment was cast off by the Defense Department at the end of World War II—except for two robots—the charitable gift of a Japanese company and gesture of good will. Students must have access to current State equipment and computer technology if their education is to be effective. All levels of education must do a better job of preparing our people to participate in an increasingly complex technological society.

Education has traditionally been a governmental responsibility. Given the importance and the dimension of the crisis we face, I believe that the support is there for this Congress to launch major initiatives in math and science education, which, as you say in the title of your bill, are "emergency" needs.

Legislatively, there have been generally five approaches discussed in Congress in recent years. First, some bills provide for blue-ribbon commissions to make overall policy recommendations. Second, there has been legislation to provide fellowships for graduate students and loans or grants to college students preparing to teach math and science.

A third approach provides direct grants to schools to improve the quality of instruction and education in math and science. A fourth type of bill provides preferential tax treatment for industries willing to participate in joint employment or training programs with eductional institutions, such as sharing equipment and expertise. And a fifth legislative approach provides tax benefits for firms that donate computers or other equipment to elementary and secondary schools.

In my opinion, the problem we face is so broad that we are going to have to use all of these appproaches. The problem is in the workplace and in the schoolroom. It is at all levels and facets of education. The problem is society-wide. And every level of our society has some contribution to make to its solution.

In the last Congress, the House Science and Technology Committee and the House Education and Labor Committee developed two different approaches to our math and science crisis. In my view, both are worthwhile and essential. I believe we should take the strengths of both and produce a comprehensive or "omnibus" legislative response to satisfy the many needs.

In general terms, I tend to think that the National Science Foundation has a history of supporting the fellowship approach in post-secondary education in providing educational opportunities. And the NSF may be best able and most experienced to support partnership projects with industry, such as giving students opportunities to use and train on advanced equipment or encouraging private sector talent to share their knowledge in the classroom.

It may be that the Department of Education, with its broad focus on all levels and aspects of education and with its long-established mechanism for providing Federal funds to State and local education agencies, is the appropriate agency to provide support to elementary and secondary schools.

I do not see these approaches as incompatible or competitive. I think they point the way toward coordination at the federal level using the strengths and expertise of both agencies.

I personally feel that the development of these legislative approaches in the last Congress show that we need several approaches. I look forward to working with this committee in hopes that when we look back on this part of our history, we will be able to say that the 98th Congress was the Congress that made the greatest difference in math and science education.

Thank you very much for the opportunity to testify.

Chairman PERKINS. Now we want to get along. We are running way behind time.

Our next witness is our colleague, Mr. Wortley, from New York.

STATEMENT OF HON. GEORGE C. WORTLEY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW YORK

Mr. WORTLEY. Chairman Perkins, members of the Subcommittee on Elementary, Secondary, and Vocational Education, I commend you for your efforts to improve our present system of science and mathematics education.

There has been a great deal of discussion about the crumbling defense-industrial base in the United States. The subject of productivity crops up at cocktail parties, PTA meetings, and bus stops. Everyone agrees that the problem is real but a consensus has failed to materialize about what can and should be done to turn the situation around.

I speak with some familiarity on the subject. As a member of the Economic Stabilization Subcommittee, I participated in most of the 29 days of hearings that panel conducted in 1981 and 1982. Because a diversified economic base is integral to the survival of a nation as large and sophisticated as ours, I am greatly troubled over the state of science and mathematics education at all levels. Basic education is the cornerstone of any rebuilding effort.

For a variety of reasons known all too well by members of this subcommittee, our investment in these necessary fundamentals has lagged far behind other industrial nations, especially the Soviet Union, Japan, and Germany.

Once the United States led the way in producing mathematicians, engineers, biochemists, and other technically oriented people who kept our Nation in the technological vanguard. Sadly, this is no longer true. Why?

Because we have a shortage of qualified science and math teachers who are willing to teach in the elementary and secondary schools. They are unwilling to do so because they cannot afford to work for low wages. Colleges and universities are losing quality faculty members for much the same reason. An equipment shortage compounds the problem. In many schools, much of the scientific equipment is obsolete but the institutions have no plans to replace it any time soon. Serious researchers are compelled to enter the private sector to continue their work.

Syracuse, N.Y., where I come from, is like many other medium-size cities. For several years the local school district has limped along because it has been unable to attract science and math teachers for its elementary and secondary schools. Limited enrollments in math and science education have taken their toll on the availability and quality of instructors. To reverse this trend, the city of Syracuse school system, in conjunction with Syracuse University, has come up with a trial program.

The city underwrites an internship program in which it pays selected graduate students in mathematics a small stipend as well as tuition to Syracuse University. The student intern teaches in the Syracuse public school system under the supervision of senior teachers and the SU faculty. The program has been in existence for 3 years with good results. However, it is small. Only 12 students are now teaching as math interns. Although this program has helped fill in some of the gaps that exist in the Syracuse school system, it cannot on its own be expected to solve the larger problem, too few students in science and mathematics education. Right now, Syracuse University is one of the few schools in New York State that still prepares students for teaching careers.

It has been said that there is a direct correlation between what goes on in the third grade and who wins the Nobel Prize. If appropriate steps are not taken soon, there will be little hope of keeping up with the rest of the industrialized world.

Betty Vetter, Executive Director of the Scientific Manpower Commission, appeared before the Economic Stabilization Subcommittee in July 1981. Her testimony made quite an impression on me and other members who heard her that day. She made the point that U.S. industry has had the good sense to offer decent salaries to graduates of the technical disciplines. Such salaries have risen faster than those in any other field of employment. She went on to say, however, that this practice has become a two-edged sword:

> New master's graduates in geology, chemistry and engineering will start work this year at more than $25,000 per year in industry. Newly minted Ph. D.'s in engineering, chemistry, operations research and physics can begin their industrial careers at $28,000 to $30,000 on average. And that is a basic cause for a serious problem. The increasing pressure on students electing majors in fields where job opportunities beckon, coupled with excellent prospects in nonacademic jobs, has created severe faculty shortages in schools and departments of engineering and computer science.

She added:

> The quality of graduates is also in danger. Larger classes, overburdened professors, teaching assistants with language barriers and obsolete laboratory equipment threaten the educational excellence which is particuarly crucial of the supply is also limited.

She's right. In our efforts to rebuild and revitalize America, we must begin by wisely investing in human capital that will bring about the American renaissance.

H.R. 30 won't solve all the problems, but it represents a good starting place. It is a small down payment on America's future.

Thank you, Mr. Chairman, for the opportunity to appear before you today to discuss an important problem and potential solution. I commend you and your committee for your efforts in this direction.

Chairman **Perkins**. Let me commend you.

Mr. **Goodling**. I, too, want to thank you for your excellent testimony. You hit a number of areas dear to me, including why we have to start on the elementary level. I could probably add a little bit to why teachers leave teaching.

Chairman **Perkins**. Mr. Biaggi.

Mr. **Biaggi**. No questions.

Chairman **Perkins**. Mrs. Roukema.

Mrs. **Roukema**. Thank you, Mr. Wortley.

As a comember of the Economic Stabilization Subcommittee, I appreciate the fact that you brought to the attention of this committee some of the very relevant factors that we studied. There is no question that what we are doing here is really part of the total revitalization of our industrial base, not simply an educational problem, or isolated educational problem.

Thank you.

Mr. **Wortley**. It is part of the big picture.

Chairman **Perkins**. Thank you very much for your appearance here today, we appreciate your coming.

Our next witness will be Congressman McCurdy.

You go right ahead, Mr. McCurdy.

STATEMENT OF HON. DAVE McCURDY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF OKLAHOMA

Mr. **McCurdy**. Thank you, Mr. Chairman.

Mr. Chairman and members of the committee, it is a pleasure to appear before you again to discuss my legislative initiative to combat the critical shortage of math and science teachers. I commend you for recognizing the importance of this type of legislation. Reversing the dangerous trend toward scientific illiteracy must be a top priority of the 98th Congress.

It is our educational system that has enabled us to advance faster and farther than any other country in the world. Our future hinges on high technology, but we do not have the science and math teachers to prepare our young people for their roles in a technological world.

In 1981, 43 States reported a shortage of math teachers; 42 States reported a shortage of physics teachers. Over the last 10 years, there has been a dramatic decline in the number of college graduates with degrees in math and science education—a 77-percent drop in math, a 65-percent decrease in science. According to a survey of secondary school principals, 50 percent of the math and science teachers in our classrooms are unqualified and teaching with emergency certificates.

The key to a quality education is a quality teacher. One of the first steps toward improving math and science education must be a program to attract, retain and update talented teachers. No matter how much time and money we invest in curriculum and equipment, if we don't have the qualified teachers the trend toward scientific illiteracy will continue. If we allow that to happen, we can expect to surrender our position of world economic, scientific, and military leadership.

I have just returned from a Science and Technology Committee trip to Japan. Before getting into the details of my legislation, I would like to share with you my findings and impressions of the Japanese people.

After several days of meetings with Japanese officials representing government, education, and private business, what struck me most was their uniform cooperation. At the close of World War II, the Japanese recognized that a high quality of education must come before productivity and prosperity. They know that education planning is a vital component of economic planning. They have set high standards of scientific literacy for all Japanese citizens.

During a meeting which I led on science education, I asked the minister of education what kinds of incentives the Japanese provide to teachers. Mr. Nakajima replied that during the 1970's Japan also experienced a shortage of public school teachers. The Ministry of Education developed a national program to attract and retain high quality teachers. Since the Diet passed a 1974 law to provide higher pay for public school teachers, teacher salaries have increased four times. Today the average Japanese school teacher earns 20 percent more than a deputy minister in the Japanese Government.

I was also impressed by Japanese laws to increase child care leave for female teachers and to improve insurance and survivor benefits. They have made enormous investments in teacher retraining programs. In Japan, teaching is one of the most respected professions. The Japanese are attracting and retaining teachers. Their students are performing better than American students on science and math achievement tests.

In a study of science achievement conducted by the Center for Educational Statistics, Japanese 11-year-olds performed better than American 14-year-olds and Japanese 14-year-olds performed better than our 17-year-olds. Their young people are pursuing careers in science, math and engineering. For each engineer produced by the United States in 1981, Japan produced 2.6, and they have one-half of our population.

We can learn a lot from the Japanese commitment to excellence in education. I only hope that we, as representatives of the people, can join with industry, educators, and the general public in an effective response to the science and math education crisis in America.

The legislation which Senator John Glenn and I have introduced directly attacks the teacher shortage.

Mr. Chairman, at this point I might comment that Senator Glenn expressed his regret at not being able to testify this morning. I understand he has a statement for the record.

The legislation provides incentives for students to pursue math and science teaching careers. Plus, it gives them an incentive to stay in the classroom.

The Pre-college Mathematics and Science Teacher Assistance Act, which I introduced, House Resolution 835, amends the Higher Education Act of 1965 to establish a direct student loan program for college students who pursue careers in pre-college math and science teaching. For each year that the borrower teaches, a certain percentage of the loan will be forgiven. If the borrower does not go into science and math teaching, he or she will be required to pay back the loan in full with 9 percent interest. The Congressional Budget Office has estimated that the program will cost $12 million in the first year and work its way up to $57 million by the fourth year.

House Resolution 836 grants tax credits to high tech firms that hire precollege math and science teachers during the summer or allow their certified employees to teach math or science part-time in the local schools. These tax credits would supplement teacher salaries and provide them with hands-on high technology experience to prepare their students for future jobs.

While we believe that the loan will attract talented new blood into teaching and the tax credit will help retain them in the classroom, we also need a program to update and upgrade the skills of our teachers. Senator Glenn and I will shortly be introducing a more comprehensive bill which includes the loan program and a second title for an inservice teacher training program.

Mr. Chairman, this legislation is targeted to a specific need and cannot alone solve the crisis in science and math education. It does, however, directly attach the teacher shortage and I believe it is a vital component of the overall solution.

I appreciate having this opportunity to testify and I urge the committee to support this legislation. As a member of the Science and Technology and Armed Services Committees, I look forward to working with you and stand ready to assist you in any way I can.

Mr. Chairman, I might mention that some of the groups testifying today have supported the bills that we introduced last year. Again I appreciate you allowing Senator Glenn and me to testify last summer on this matter.

I am not concerned about the jurisdiction of committees; I am concerned about the shortage of math and science teachers, and the need to move in the field of high technology. I only wish I could be on a third committee. If I could do so, I would have selected this committee, because I believe we are facing not only an economic problem, a high technology shortage and a shortage of skilled personnel, but also a military threat.

Being on the Armed Services Committee, I am concerned about the training and quality of personnel in that area, and I believe that the schools are the first place to begin.

I know a number of members have stated already that they were pleased to see the President's state of the Union message address this problem—even though there are differences in opinion as to the vehicle or method for addressing the shortage. I am pleased he has finally recognized the need to address this and hope that the reversals that were made last year in the science and technology area, such as engineering education moneys and the loan programs there, will be reinstated and hopefully there will be a reversal in the proper direction this year, by increasing the funding for those programs.

Mr. Chairman, that concludes my formal statement. I certainly stand ready to answer any questions.

Chairman **Perkins**. Let me congratulate you, Mr. McCurdy, for an excellent statement.

Of course I have served with many of your predecessors here over a period of years. Carl Albert was here when we enacted the National Science Foundation as a high-level research program. That was during the cold war days—so we could keep ahead of the Russians in the sciences.

Now, there will not be, I don't think, much of a dispute over jurisdiction. We want to obtain the same results that you want to obtain. And I am sure that Carl Perkins and Don Fuqua and others can solve these problems without difficulty. We will move forward at the earliest possible date.

I want to thank you for an excellent statement.

Mr. Goodling.

Mr. **Goodling**. I have a lot of questions.

I was going to ask you about Japanese education, but not at this time because we are so far behind. I will be interested to know how many parent advisory groups they have, how many grievance committees, whether they reward excellence and whether it is an education of the masses, as we do here, et cetera?

I will ask you all those questions, but I won't do it now.

Mr. **McCurdy**. If the gentleman will yield, I would quickly state that in the 2-day meetings we had with the Japanese Diet, including their Ministry of Education, the one section that we devoted to science and math education perhaps elicited the most response from the Diet members. It is the one section in which they were the most vigorous in their responses and were perfectly clear in their commitment, not only from the legislative standpoint but that they believed that industry and labor and the parents themselves were strongly beind the initiatives in that area.

We also had meetings at Tokyo University with a number of graduate students and students at Tsukuba, which is the science city, which also had some interesting requirements, which again I would gladly visit with anyone on it at a later time.

It was a remarkable experience to have the opportunity to meet with the Japanese regarding science and math education and to see the outright commitment. They are just amazed at the problems we are facing. It is beyond their comprehension. They cannot understand why we as a nation, as large and as strong and as powerful, are facing the problems that we are today. It is beyond their comprehension, and almost beyond mine.

Mr. **Goodling**. I could tell them in an hour.

Chairman **Perkins**. Mr. Boucher.

Mr. **Boucher**. Mr. Chairman, I didn't have an opportunity to hear the opening comments of the speaker, so I will pass at this time.

Chairman **Perkins**. All right.

Mrs. Roukema.

Mrs. **Roukema**. No questions.

Chairman **Perkins**. Mr. Gunderson.

Mr. **Gunderson**. Mr. Chairman, thank you.

Dave, I want to compliment you on your statement. You look at the problem from a rather wide range. But I in particular would be interested in following up on the in-service training and really getting at the whole issue of teachers. You can have all the equipment in the world and if you don't have the teachers there to teach it, it simply doesn't do any good.

I think that is the area we have to focus on first and foremost. Anything I can do to work with you in either taking present teachers moving them into the science area—probably that is preferable to bringing new teachers, but anything I can do in that area, I stand ready to work with you.

Mr. **McCurdy**. I thank the gentleman for his input and the support to the legislation.

The in-service question is a very important one, and one that the Japanese stress very clearly. They had a bill that passed in the 1950's that was a private sector educational bill which provided subsidies for programs and for retraining programs. And again, this was back in the 1950's when they were addressing this problem. And they have maintained an amazingly high level of commitment to that, because they see that is their number one problem.

They also provide the incentives because they understand that they have to have the teachers there in order to prepare students for industry. They are not hiring away teachers at the rate we are. Industry is not stripping the educational system of the qualified personnel the way we are facing that today. I only wish that more industry leaders, and I think they will eventually wake up and come around to this position, will be stressing this kind of in-service cooperation which I think is very vital to the legislation before us.

Chairman **Perkins**. Thank you very much.

Mr. **McCurdy**. Mr. Chairman, again thank you very much for your patience in allowing me to come in.

Chairman **Perkins**. We hope you will come back again.

Our next panel consists of Ms. Mary Futrell, secretary-treasurer of the National Education Association; Mr. Harold Raynolds, commissioner of education, State of Maine, representing the Council of Chief State School Officers; Mr. Scott D. Thomson, executive director of the National Association of Secondary School Principals; professor Rustum Roy of the Brookings Institution; and Dr. Harold Patterson, superintendent, Spartanburg, S.C., representing the American Association of School Administrators.

STATEMENT OF MARY HATWOOD-FUTRELL, SECRETARY-TREASURER, NATIONAL EDUCATION ASSOCIATION

Chairman **Perkins**. First we will hear from Ms. Futrell.

Ms. **Futrell**. Thank you very much. My name is Mary Futrell and I am the secretary-treasurer of the National Education Association, which represents teachers, higher education faculty, and educational support personnel in all 50 States.

As a representative of nearly 1.7 million members nationwide, I welcome this opportunity to present the NEA's views on the Emergency Mathematics and Science Education Act, H.R. 30. My testimony will be brief and I would like to request at the outset that my complete statement be included in the record.

Chairman **Perkins**. Without objection, all the complete statements will be inserted in the record.

Ms. **Futrell**. Mr. Chairman, you are to be complimented on your foresight in introducing this bill, and for the timeliness of these hearings on the Nation's pressing math and science education needs. Last evening's State of the Union address, and the Democratic response to it, made it clear that the challenge for the future in education in these areas is awaiting us now.

I would also like to take a moment to mention the important role played last evening by North Carolina Governor James Hunt in his response for the Democrats to the President's State of the Union address. Governor Hunt, who also serves as chair of the Education Commission on the States, made direct mention of Democratic support for the American Defense Education Act, which you, Mr. Chairman, are sponsoring this session of the Congress. We, too, believe that the ADEA will play a key part in the revitalization of American education.

It is within the context of the ADEA, Mr. Chairman, that I will address our concerns about the Emergency Mathematics and Science Education Act. For while we heartily support passage of H.R. 30, we must stress that we view it only as a partial response to the math and science crisis in our education system. The $250 million in funding allocation for the Emergency Mathematics and Science Education Act represents a mere $6 per student nationwide. But the problems we confront in math and science will require a much more extensive effort and greater financial commitment—one that can be found within the American Defense Education Act.

The most telling media event of recent weeks pointing to the need for swift enactment of the Emergency Mathematics and Science Education Act was Time magazine's choice of its coveted man of the year award for 1982—none other than the computer.

Whoever would have guessed some years back that Henry Kissinger, Anwar Sadat or Ronald Reagan would have had such unusual company? I know that Time's choice was a controversial one for many, but whatever one's personal opinion, this symbolic choice is yet another statement verifying that the technological revolution is here to stay, and like all revolutions, its impact on all our lives will indeed be both profound and felt for many years to come.

I would like to highlight some of the relevant points the NEA made during its testimony on the ADEA last fall to restate our support for a comprehensive and meaningful response to today's educational challenges.

First, there is not much difference of opinion nationally when it comes to defining the core ingredients that have helped build America's greatness: unprecedented economic growth is always listed at the top. Sustaining that economic growth provides a crucial foundation for maintaining this greatness, and underlying that growth is the need for an educated, skilled labor force.

Yet, a 1982 report prepared by the Education Commission on the States, "Information Society: Will Our Graduates Be Ready?" predicts that skilled labor shortages will be the major obstacle to future growth in the United States.

Second, projected labor force needs show strong growth in job areas such as engineering, computer work or electronics, all of which require math and science skills. Yet, U.S. students are taking fewer courses in these subject areas than ever before. They are not keeping up with their counterparts in other competing countries such as the U.S.S.R., West Germany or Japan. Feeding into this problem is the shocking shortage of science and math teachers across the country.

To better understand how these problems are going to affect us, I would like to review some factors that will be key in determining the future direction of our society:

The face of our Nation is being changed daily by the most striking demographic shifts in our entire history. Apart from continual growth in the population, a rise in the number of elderly, and shifts in population from the Frost Belt to the South and West, a number of other dramatic changes are occurring.

The phenomenal increase in the number of women working outside the home is expected to continue. In addition, the increase of our minority populations will continue, with the largest rise occurring among Hispanics.

The explosion in technology is an earthquake in our midst—one that is causing a huge shake—up in the very foundations on which our economy, society and culture are based. This technological revolution is affecting our work lives, family lives, governmental policies, and cultural expression. And it is one that, by necessity, is impacting on our education policies.

As the revolution in technology is affecting nearly every facet of our lives, so it is also—even more dramatically—on our defense needs and structure. Weapons and weapons systems are increasingly complex and sophisticated, and they require increasingly well trained and highly skilled people to operate them.

With this brief scenario established, I would like to turn to the specific point of the Emergency Mathematics and Science Education act. We believe that it is a fitting prelude to passage of the ADEA, and as with the ADEA, its focus on direct local funding and programming will be vital to its success.

The Emergency Mathematics and Science Education Act, which we hope to see implemented at the local level beginning in the fall of this year, wisely provides for important evaluative and planning work. This aspect of the bill, especially given its limited funding and time frame, is fundamental. Time spent in evaluating and planning under H.R. 30 would effectively set the stage for passage, and enhance the implementation of the ADEA.

We applaud the call within the bill for various sectors of the community—teachers and local school boards, business and labor, and others interested in education—to work together in developing and implementing tailor-made programs. We stress here that teacher involvement is central.

We also feel that the section of the act which appropriates funds for summer institutes, teacher centers and workshops for teachers—again with teacher involvement in the planning—will be vital.

There is an important way this bill could be strengthened. An information-gathering, evaluative role for the Government Accounting Office, under Congressional direction, would provide a critical, impartial analysis of need. We believe that a role for the GAO should be built into the legislation from the beginning.

Mr. Chairman and members of this committee, we at the NEA ask you to take the leadership in Congress to call the attention of the American people to a national problem: to maintain quality and excellence in our education system so that we may keep astride the monumental changes sweeping us into the next century. We believe that the Emergency Mathematics and Science Education Act will help further this goal. We stand ready to work with you and the American people to reach this end.

Thank you very much.

[Prepared statement of Mary Hatwood-Futrell follows:]

PREPARED STATEMENT OF MARY HATWOOD-FUTRELL, SECRETARY-TREASURER, NATIONAL EDUCATION ASSOCIATION

Mr. Chairman: My name is Mary Hatwood-Futrell, and I am secretary-treasurer of the National Education Association (NEA), which represents teachers, higher education faculty, and educational support personnel in all fifty states.

As a representative of nearly 1.7 million members nationwide, I welcome this opportunity to present the NEA's views on the Emergency Mathematics and Science Education Act, (H.R. 30).

We believe that this legislation could provide an important beginning on an important question—can we as a nation provide an education to all America's children which is geared to the future rather than one which is wedded to the past? We believe that it is both timely and important for Congress to pass the Emergency Mathematics and Science Education Act as part of an overall strategy to improve education in these areas.

Before going any further, Mr. Chairman, I would like to thank you for your foresight in introducing this bill to provide emergency assistance from the national level to local schools to develop an immediate response to science and math needs. As any of us within the education community, and indeed anyone who has been following educational trends in recent years knows, the gap in science and math preparation in our nation's schools is growing to crisis proportions.

Everywhere, one reads or hears, "Computer education not keeping up with fast-paced changes in technology," or "Soviet students overtaking their U.S. counterparts in math and science training," or "U.S. bid in technology race dampened by lack of skilled workforce." The evidence is everywhere. An emergency response is needed. And we believe that the response is passage of the Emergency Mathematics and Science Education Act.

Yet, at the same time that we laud the Chairman's action introducing the Emergency Mathematics and Science Education Act, and heartily support its passage, we must reiterate our position of viewing it only as a partial response to this crisis in our education system. This bill must become law, but it is imperative that it be seen as part of a larger and far more comprehensive program such as that encompassed by the American Defense Education Act (ADEA) introduced by you, Mr. Chairman, in the 97th Congress and scheduled for introduction in the 98th Congress.

As we all realize, the $250 million in funding allocation for the Emergency Mathematics and Science Education Act represents a mere $6 per student throughout the country. It begins a planning process. However, the problems we confront in math and science will require a much more extensive effort and greater financial commitment. The need for rapid improvement and expansion of our educational resources comes at a time when the 15,000 local school districts and 50 states are reeling from the effects of the recession and budget cuts at the federal level.

During hearings on the American Defense Education Act last fall, Members of this committee heard from illustrious and concerned witnesses, including your own colleagues from the U.S. Senate, representatives from industry, education, and from prestigious institutions such as the National Science Foundation. All expressed dire warnings about the state of science and math training as it impacts on our nation's ability to maintain her place in the increasingly competitive international economy, to stay as the leader in the development of advanced technology, or to have a national defense that is truly secure—both from outside threats and internal decline. All these witnesses called on you as legislators to carry out your mandate of public information and education to confront and deal legislatively with the issues raised in the ADEA.

The most telling media event of recent weeks pointing to the need for swift enactment of the Emergency Mathematics and Science Education Act was "Time" magazine's choice of its covered 'man of the year' award for the 1982—none other than "The Computer."

Whoever would have guessed some years back that Henry Kissenger, Anwar Sadat or Ronald Reagan would have had such unusual company? I know that "Time's" choice was a controversial one for many, but whatever one's personal opinion, this symbolic choice is yet another statement veryifying that the technological revolution is here to stay, and, like all revolutions, its impact on all our lives will indeed by both profound and felt for many years to come.

I believe that many of the points made during the two days of ADEA hearings are relevant to our discussion of this emergency bill. I will touch on several of the points the NEA made in that testimony in order to restate our support for the need for a comprehensive and meaningful response to a pressing national need for which this bill is a first step.

ADEA: A COMPREHENSIVE RESPONSE TO A NATIONAL CRISIS

There is not much difference of opinion nationally when it comes to defining the central ingredients that have helped build America's greatness: unprecedented economic growth is always listed at the top. Sustaining that economic growth provides a crucial foundation for maintaining this greatness, and underlying that growth is the need for an educated, skilled labor force.

Increasing education is the major source of economic growth in the U.S. since 1930, according to the Brookings Institute. They argue that improved education accounted for two-thirds of the increased growth in the American economy from 1948 to 1973, a 25-year period of remarkable economic growth that was coupled with an extraordinary increase in public investment in education. Coversely, a 1982 report prepared by the Education Commission of the States, "Information Society: Will Our Graduates Be Ready?", predicts that skilled labor shortages will be the major obstacle to future growth in the U.S. Indeed, we will face a long-term crisis if we do not begin to seriously concentrate on preventing these shortages.

MATH AND SCIENCE EDUCATION NEEDS

Hundreds of media stories in the last year have centered on the current post-Sputnik math and science crisis in the U.S. At a time when projected labor force needs show strong growth in jobs areas such as engineering, computer work or electronics, all of which require math and science skills, U.S. students are taking fewer courses in these subject areas than ever before. (See appendix A)

Statistics comparing years of training in math and science between U.S. students and their counterparts in other competing countries such as the U.S.S.R., West Germany or Japan—reveal a widening gap, with our students coming out at the bottom end of the scale.

Feeding into this problem is the shocking shortage of science and math teachers across the country. Many teachers neither specificially trained for nor certified in math and science, are pinch-hitting in the classroom in these subject areas; this, even as math and science are being hailed as the 'nation's top educational priorities'. This situation hurts teachers and studenst alike, and must be addressed to adequately respond to technological, economic or national security challenges currently facing us.

To better understand how these educational short-comings are going to affect us, I would like to reveiw some facts that will be key in determining the future direction of our society.

CHANGING DEMOGRAPHICS

The face of our nation is being changed daily by the most striking demographic shifts in our entire history. Apart from continual growth in the population, a rise in the number of elderly, and shifts in population from the Frostbelt to the South and West, a number of other dramatic changes are occurring.

The phenomenal increase in the number of women working outside the home is expected to continue. This will mean not only that services such as dependent care will need to be improved, but also that educational opportunities will have to be expanded, especially with regard to retraining needs for workplace skills. In addition, new approaches to the workday, such as flex-time and work-at-home arrangements will by necessity become more commonplace.

In addition, the increase of our minority populations will continue, with the largest rise occurring among Hispanics. This will add tremendously to the need for bilingual education programs. And, since 30-40 percent of the labor force growth over the next decade is expected to occur among Hispanics, it will be imperative to raise the proportion of high school graduates among this group above the current 55 percent level.

THE TECHNOLOGY REVOLUTION: THE ROLLING WAVE INTO THE FUTURE

Some would describe the technological explosion as an earthquake in our midst—one that is causing a huge shake-up in the very foundations on which our economy, society and culture are based. Alvin Toffler, in his book The Third Wave, describes the profound changes that the technological revolution has wrought as the "single most explosive fact of our lifetime." It is one that is affecting our work lives, family lives, governmental policies, and cutural expression. And it is one that, by necessity, is impacting on our education policies as well. This revolution—during which many of us go about our daily business at times even unaware that we are in the midst of such upheaval—has been catapulting the workplace into a laboratory of innovation and change; replacing our former goods-producing economy into one based increasingly on service and information; and restructuring almost entirely our means of communications. This revolution in technology indeed promises no end in the foreseeable future.

The explosion in technology has not been confined to the U.S. Countries such as Japan are in many ways surpassing our own technological capabilities. This fact alone has been important in the development of the heightened competition between our economy and those of many other countries. Without an adequately educated and skilled workforce, the U.S. will never be able to regain the advantage in this increasingly competitive international environment.

MILITARY AND DEFENSE NEEDS

Shifting our focus slightly from the international economic arena brings us to the area of national security. As the revolution in technology has impacted on nearly every facet of our lives, so has it also—even more dramatically—on our defense needs and structure. Weapons and weapons systems are increasingly complex and sophisticated, and they require increasingly well trained and highly skilled people to operate them. This increasing sophistication of military technology and management needs calls for great strides to be made in the basic and advanced skill levels of armed forces personnel with regard to math, science, technology and communications.

Yet, the ability to operate and maintain weapons and weapons systems cannot be our only goal with regard to military training. The constant threat of nucear annihilation makes it imperative that our military leaders think of themselves as men of peace, not war. Just as our nation cannot have a truly secure national defense unless its citizens are healthy, well-educated and employed, neither can our military leaders play a vital role in keeping world peace if they think of themselves only as soldiers. A broad view of education must remain a goal for all our nation's citizens. It is indeed one of the best hopes for the future, not only for our country, but for the entire human race.

In reviewing some of the points made in our statement on the ADEA, I would like to add that charts detailing this general information are attached as appendices to this statement.

Even since you held hearings on the ADEA in September, Mr. Chairman, a great deal more has been highlighted in the media about the ongoing and increasing need for a stepped up national commitment to math and science training in the U.S. Some of the more dramatic figures recently issued are:

Current U.S. employment stands at roughly 12%; yet the only jobs which are going begging are in highly skilled areas requiring math and science backgrounds. For example, the Washington Post classified ads for Sunday, January 23, 1983, listed more than 100 separate employers seeking candidates for high level computer jobs; more than 70 employers seeking engineers, and over 70 searching for registered nurses. It is clear that having enough people trained to fill these jobs will not solve our nation's unemployment crisis, but it does provide us with important guidelines for our training and education needs.

This current trend promises to hold for the future too. A study by the Electronic Industries Association published in May, 1982 projects a significant growth in the demand for technological personnel, both in professional and para-professional categories. Between 1981–85, most job category needs are expected to increase over 20 percent per year, with the greatest growth in the general fields of electronic and software engineering.

This heightened demand for engineers was underscored in a November, 1982 Chicago Tribune article, "The New Worker" which highlighted math and science needs. The article quoted a forecast by Thomas Martin, Jr., president of the Illinois Institute of Technology, which projects that by 1990, 300,000 engineering jobs in the U.S. will go unfilled due to the lack of expertise in math and science skills among U.S. students. Yet, the Electronic Industries Association in the above-cited study, points out that the percent of foreign, non-immigrant nationals receiving graduate degrees in engineering has continued to rise in the last two decades. The study states, "The number of foreign non-immigrant nationals receiving graduate degrees in engineering as a percent of the total number of engineering degrees granted by U.S. universities continue to increase. At the master's level, this ratio has increased to 1 in 4, while at the Ph.D. level, over one third of all engineering recipients are foreign nationals."

The media has also shed light on the widening gap between the haves and the have-nots in school districts throughout the country. For example, school districts in wealthy areas, and students in private schools, are being exposed to computer and information processing machinery in much greater numbers than are their poorer counterparts. This gap will become increasingly important, as, in the words of a vice president of the hi-tech giant TRW put it in a November, 1982 "Time" magazine article, "Peering into the Poverty Gap": "It's not just a matter of number crunching. It's a new way of thinking. The kids who don't get indoctrinated to computers by seventh grade are not going to develop the same proficiency (as others)." A computer education specialist with the National Science Foundation added in the same article: "Power is not distributed evenly now, and computers will broaden that gap."

In the midst of these ongoing revelations about math and science needs and the changing basis of our workforce and economic priorities, we find that the current Administration lacks the wisdom to develop a strategic plan of action at the federal level to begin to address the concerns and needs that I have outlined. Indeed, we still find ourselves fighting for crumbs as the Reagan Administration continues its attacks on federal education programs as fundamental as those aiding reading, writing and math skills, such as Chapter I of the Educational Consolidation and Improvement Act (formerly Title I.) We therefore can hardly expect any meaningful leadership initiative for a concern as vital as math and science education from an Administration which looks to the past for its future. This, Mr. Chairman, is why we look to you and your colleagues in the Congressional branch to take on the leadership role that our nation so greatly needs at this turning point in our history.

I would like to focus my attention now on the specific points of the Emergency Mathematics and Science Education bill which you will soon be considering.

THE EMERGENCY MATHEMATICS AND SCIENCE EDUCATION ACT: A GOOD BEGINNING

Let me say, first of all, that the NEA strongly endorses the Emergency Mathematics and Science Education Act largely because it recognizes and addresses the pressing concerns raised within the American Defense Education Act, and is a fitting prelude to the passage of the ADEA—a much more comprehensive and far-reaching initiative. The focus of the Emergency Mathematics and Science Education, as with the ADEA, is to provide funding directly to local school districts, and we believe, will be key to its success, since it is here that the nation's education policy is administered and operated. The Emergency Mathematics and Science Education Act would give local school districts the incentives and resources to improve programs to further the national goals of strong science and math education. As with the ADEA, the Emergency Mathematics and Science Education Act is a national recognition of a national problem, proposes a national financial commitment to help overcome the problem, yet requires the solutions to come through a local commitment to local programs. Therein lies a great deal of its strength as good legislation.

The Emergency Mathematics and Science Education Act wisely provides for important evaluative and planning work to be carried out under its auspices. This aspect of the bill, especially with regard to the call for an evaluation of local resources for, and the development of innovative responses to math and science education needs, is a responsible use of the bill's limited funding and time frame. Time spent in evaluating and planning under the Emergency Mathematics and Science Education Act would effectively set the stage for passage, and enhance the implementation, of the American Defense Education Act.

We applaud the call within the bill for various sectors of the community—teachers and local school boards, business and labor leaders, and other interested in education—to work together in developing and implementing tailor-made programs. We stress here that teacher involvement is key. Without that involvement, the problems to be addressed might be theoretical and not practical. This could lead to solutions that would be misguided and ineffective unless the professional classroom voice is heard.

We believe that the section of the Act which appropriates funds for summer institutes, teacher centers and workshops for teachers—again with teacher involvement in the planning—will serve to increase their skills in using the latest equipment and resources to improve classroom instruction.

In that same vein, the Emergency Mathematics and Science Education Act's "Congressional Scholarships", while available to fewer than 1000 individuals during the life of the Act, represents an important commitment to the development of adequately prepared teachers of math and science for our elementary and secondary schools. Again, we feel that any such program must also be continued in the future for it to leave a lasting mark on science and math education in the U.S.

Moreover, the bill's provisions to strengthen education research and development are vital. Its call on the National Institute of Education, in conjunction with other appropriate federal agencies to support improvements in research in the physical sciences and teaching students, as well as in the use of instructional technologies and in the analysis of local and institutional policies "enhancing or inhibiting the recruitment, retention, and upgrading of mathematics and science faculties" would be a very wise use of federal funds.

We find this aspect of the bill to be particularly useful since a recent study prepared by the Electronic Industries Association pointed out that although overall National Science Foundation (NSF) funding has increased steadily, funding for science education has dropped significantly, from nearly 50 percent of the entire NSF budget in 1959 to 7 percent in 1981, 2 percent in 1982, and an infinitesimal 1.4 percent budgeted for 1983 (see Appendix A).

ENHANCING LOCAL INITIATIVES THROUGH FEDERAL EVALUATION

There is an important way that this bill could be improved. An information-gathering and evaluative role for the Government Accounting Office (GAO) would provide a critical analysis of needs. Having the GAO collect data in math and science education which show trends in student participation, student achievement levels, upgrading of state teacher certification standards, the numbers of teachers needed and employed, and the number of teachers graduating from schools of education could provide localities with vital resources on which to base many of their planning initiatives.

In addition, the GAO should conduct a national study to determine costs nationwide for modernizing and expanding courses in math, science, communications, foreign languages, and technology. Another important role for the GAO in implementing the Emergency Mathematics and Science Education Act would be in the collection of data showing how math and science education fulfills needs in defense, high-technology industry, newly emerging occupations and worker retraining, and in meeting equal educational and employment opportunities for minorities and women.

In addition to providing localities with invaluable information, the GAO involvement would also give the Congress easy access in the evaluation of the Act. Keeping evaluation of the program under the auspices of the Department of Education at this particular moment in our history would be akin to leaving the cat in charge of the barnyard mice. We believe the GAO has a vital role to play, and that it should be one that is built into the Emergency Mathematics and Science Education Act from the beginning.

Mr. Chairman and Members of this Committee, the NEA comes before you to ask that you again take the leadership in the Congress to call attention of the American people to a national problem: to maintain quality of and excellence in our education system so that we may keep astride the monumental changes embracing us as the wave of the technology sweeps us into the next century. We believe that the Emergency Mathematics and Science Education Act provides us with the basis of a foundation to once again reestablish this country's great technological and industrial achievements. We look to you and the American people for our future, and we stand ready to work with you toward these goals.

Thank you very much.

APPENDIX A

MATH AND SCIENCE CONCERNS

Currently, American youth in the 15,000 school districts across the country are not adequately prepared to take on the economic, technological or national security challenges facing the nation. For example:

Fewer students are taking fewer courses and spending fewer hours studying math and science.

A 1980 survey prepared by the Center for Education Statistics of a representative sampling of high school senior graduates in the U.S. revealed that only one-third of those sampled had taken three years of math or more. While more than half of academic students had taken at least three years of math, only a fifth of the general and vocational students graduate with three years of math.

This same Center for Education Statistics survey also revealed that only 41 percent of academic students completed three or more years of science courses, with 13 percent of general students and 9 percent of vocational students taking that same number of years in science.

The growing shortage of math and science teachers has become critical.

There are only 10,000 physics teachers in the nation's 15,000 school districts.

An Iowa State University study prepared in the fall of 1982 showed that a survey of education departments in 45 states revealed that 40 state offices reported either shortages, some critical, or mathematics teachers, and 39 reported shortages, again, some critical, of chemistry teachers.

The federal government's commitment to research and development, and to science education in general began to decline in the 1960's with support for graduate fellowships in science and math, and for teacher training institutes and curriculum development dropping dramatically in the last two decades.

A study produced by the Electronic Industries Association showed that although the National Science Foundation has been receiving steadily increasing funding over the years' funding for science education has dropped significantly from 47% of the total NSF budget in 1959 to 7% in 1981, 2% in 1982, and a budgeted 1.4% in 1983.

APPENDIX B

DEMOGRAPHIC SHIFTS

Some of the following demographic shifts will have a dramatic impact on our society for years to come:

The Census Bureau predicts that out population will increase by 18 percent by the year 2000—jumping from the 1980 figure of 226.5 million to 267 million.

The median age of Americans will climb from 29 in 1977 to 33 by 1990. By 2000, there will be more than 36 million Americans over the age of 65, and they will constitute more than 13 percent of the population.

A "baby boomlet" is expected to occur through 1985, as the number of women between the ages of 18 and 34 moves from 32.1 million in 1979 to 33.9 million in 1985.

Minorities will account for more than half the population increase in the next two decades because of high birth rates and immigration. By 1985, the non-white population will equal more than 22 percent of the total U.S. population, while white non-Hispanic Americans will drop from 80 to 75 percent of the population.

There will be a steady shift in population from the Frostbelt to the South and West, and in the Southwest, population growth will occur most among Hispanics.

The number of women between 18-64 in the workforce will continue to grow. Over half of all women between these ages now work outside the home, and by the end of this decade, more than 70% are expected to do so.

APPENDIX C

THE IMPACT OF THE TECHNOLOGICAL REVOLUTION

The rapid changes in technology will only increase in the coming years, as will its impact on all Americans' lives. The following represent a few examples:

The computer and its component industries are showing remarkable growth; this, in turn, will impact greatly on existing industries and skill requirements.

Many routine jobs now performed by low skilled workers will be done by robots ten years from now. Jobs in these 'robotized' industries will require special technical skills, as well as more knowledge and autonomy by personnel in evaluating and responding to complicated technical information.

The onslaught of the information revolution will create a need for workers with competency in computer literacy, statistics, perhaps a foreign language, and skills in engineering and the hard sciences.

There will be a continued and growing demand for scientists, engineers, and technicians both within business and industry, and within the military.

APPENDIX D

COMPARATIVE EDUCATION PROGRAMS

A review of education policies and programs in other countries may shed some light on the directions we should be taking, because the path currently followed by the U.S., and that being pursued in many other industrialized and Third World countries differs greatly:

An article appearing in the October 14, 1981 Congressional Record, "Investing in People" by Howard Samuels, revealed that 98 percent of all Soviet children now complete mandatory 10 year primary and secondary school programs, while only three-fourths of all American students finish high school. In addition, nearly every Soviet student received 10 years of math, five years of physics, four years of chemistry, five and half years of biology, five years of geography, as well as years of training in other technical subject areas.

Japan, with a population less than half as large as that in the U.S., is graduating as many engineers every year as is this country.

Material prepared for a recent Convocation on the State of Pre-College Education in Mathematics and Science by the National Academy of Sciences and National Academy of Engineering highlights programs showing that most Communist bloc and Third World countries are stengthening their pre-college math and science programs with:

National education policies emphasizing the importance of science and mathematics to economic and cultural progress. In the People's Republic of China, for example, science education policies are written into the constitution.

Specialized study in the sciences beginning in the sixth grade, with requirements in math, biology, chemistry, physics, and geography. Students spend roughly three times the number of class hours on these subjects then do their American counterparts who elect to study these subjects.

Secondary school programs balancing science and math courses with about an equal number of social science, language and humanities courses. This means that students are required to carry seven to nine courses per semester.

English is regarded as the "language of science", and is therefore widely promoted for study. Currently in the People's Republic of China, there are more students and adults learning English than there English speaking people in the U.S.

Science and math teachers are trained in specially designed programs in universities, teaching institutes, normal schools, or teachers colleges. The countries have provisions for a continuing program of in-service education, with local colleges and universities responsible for such training.

APPENDIX E

CHANGING DEFENSE NEEDS—SKILLED PERSONNEL KEY

The most sophisticated weapons systems in the world obviously require the most sophisticated minds in the world to operate and maintain them. What this shows is the importance of highly skilled personnel to meet today's Armed Forces needs: A look at how skills needs have changed and what today's requirements are is relevant:

In 1945, the Navy required that only 28 percent of its personnel be highly skilled, but by 1980, the role of semi-skilled personnel was sharply reduced, while the percentage of highly skilled personnel jumped to 42 percent. Currently, 70 percent of all Army jobs require some technical training, while 75 percent of Navy jobs require skilled or highly skilled personnel.

Despite this greatly increased need for skilled personnel, the pool that the Armed Forces currently has to choose from falls short of those needs. In recent years, the military has been forced to rewrite its training manuals from the 11th-grade level or higher to the 8th-grade level or lower. Many are aimed at the 6th-grade level.

These countries have programs for developing mass scientific and technological literacy. The People's Republic of China has the most diversified program, with its national symbol the Bohr atom model with the slogan, "Science is the Eternal Spring."

NATIONAL EDUCATION ASSOCIATION

STATUS OF FEDERAL BUDGET FOR EDUCATION
SELECTED PROGRAMS BY STATE

PAGE 1
NOV 1982

PROGRAM	APPROPRIATION FISCAL YEAR 1981 (SCHOOL YEAR XX-XX)	SEPT 1982 CONTINUING RES. FISCAL YEAR 1982 (SCHOOL YEAR XX-XX)	PRESIDENT'S BUDGET FISCAL YEAR 1983 (SCHOOL YEAR XX-XX)	POTENTIAL DOLLAR LOSS FY81 TO FY83
ALABAMA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	70,765,530	67,822,827	47,353,537	-23,411,993
ECIA CHAPTER II	9,310,777	7,973,280	7,014,534	-2,296,243
HANDICAPPED	17,233,239	18,265,877	12,796,319	-4,436,920
VOCATIONAL & ADULT ED.	15,449,346	12,999,360	9,022,985	-6,426,362
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	7,678,389	3,802,099	1,302,642	-6,375,747
REHABILITATION SERVICES	22,499,774	22,731,051	15,264,023	-7,235,751
SCHOOL LUNCH	85,886,000	78,379,000	83,431,000	-2,455,000
ALASKA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	5,591,043	7,171,317	3,773,728	-1,817,315
ECIA CHAPTER II	1,673,421	2,278,080	2,008,750	335,329
HANDICAPPED	3,611,058	3,649,980	2,557,025	-1,054,033
VOCATIONAL & ADULT ED.	1,299,180	1,150,780	798,768	-500,412
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	41,589,067	34,634,462	27,244,801	-14,344,266
REHABILITATION SERVICES	3,007,516	3,038,431	2,040,322	-967,194
SCHOOL LUNCH	6,381,000	5,823,000	6,199,000	-182,000
ARIZONA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	30,225,432	30,056,356	19,683,473	-10,541,959
ECIA CHAPTER II	5,713,026	5,330,707	4,684,822	-1,028,204
HANDICAPPED	11,770,367	12,444,527	8,718,121	-3,052,246
VOCATIONAL & ADULT ED.	9,022,691	7,778,987	5,399,472	-3,623,219
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	40,303,002	33,730,234	26,394,694	-13,908,308
REHABILITATION SERVICES	9,605,033	9,703,764	6,516,130	-3,088,903
SCHOOL LUNCH	34,444,000	31,433,000	33,460,000	-984,000
ARKANSAS				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	44,917,476	44,156,912	29,820,206	-15,097,270
ECIA CHAPTER II	4,166,966	4,556,160	4,018,740	-148,226
HANDICAPPED	12,183,001	12,705,784	8,901,147	-3,281,854
VOCATIONAL & ADULT ED.	8,807,572	7,415,346	5,147,065	-3,660,507
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	3,236,859	1,831,053	1,279,926	-1,956,933
REHABILITATION SERVICES	12,573,372	12,702,615	8,529,874	-4,043,498
SCHOOL LUNCH	44,479,000	40,591,000	43,208,000	-1,271,000

NATIONAL EDUCATION ASSOCIATION

PAGE 2
NOV 1982

STATUS OF FEDERAL BUDGET FOR EDUCATION
SELECTED PROGRAMS BY STATE

PROGRAM	APPROPRIATION FISCAL YEAR 1981 (SCHOOL YEAR XX-XX)	SEPT 1982 CONTINUING RES. FISCAL YEAR 1982 (SCHOOL YEAR XX-XX)	PRESIDENT'S BUDGET FISCAL YEAR 1983 (SCHOOL YEAR XX-XX)	POTENTIAL DOLLAR LOSS FY81 TO FY83
CALIFORNIA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	314,813,791	276,885,385	203,148,729	-111,665,062
ECIA CHAPTER II	54,246,507	43,010,190	37,937,124	-16,309,383
HANDICAPPED	83,230,066	88,108,532	61,725,197	-21,504,869
VOCATIONAL & ADULT ED.	65,616,630	55,059,834	38,217,577	-27,399,053
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	68,778,178	48,754,897	34,312,794	-34,465,384
REHABILITATION SERVICES	64,315,473	64,976,577	43,632,121	-20,683,352
SCHOOL LUNCH	304,973,000	278,315,000	296,257,000	-8,716,000
COLORADO				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	29,427,390	29,731,619	19,732,312	-9,695,078
ECIA CHAPTER II	5,470,881	5,421,830	4,799,299	-671,582
HANDICAPPED	12,590,419	13,117,755	9,189,757	-3,400,662
VOCATIONAL & ADULT ED.	9,145,673	7,628,486	5,295,008	-3,850,665
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	11,387,373	7,004,485	4,271,334	-7,116,039
REHABILITATION SERVICES	9,352,810	9,448,948	6,345,020	-3,007,790
SCHOOL LUNCH	32,238,000	29,420,000	31,317,000	-921,000
CONNECTICUT				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	25,679,857	25,238,976	16,806,199	-8,873,658
ECIA CHAPTER II	7,705,819	5,877,446	5,169,661	-2,536,158
HANDICAPPED	16,534,543	17,334,252	12,143,661	-4,390,882
VOCATIONAL & ADULT ED.	8,887,217	7,094,136	4,924,111	-3,963,106
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	5,956,151	3,891,619	2,674,782	-3,281,369
REHABILITATION SERVICES	7,978,442	8,060,453	5,412,638	-2,565,804
SCHOOL LUNCH	33,870,000	30,909,000	32,902,000	-968,000
DELAWARE				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	8,245,888	9,896,416	5,507,760	-2,738,128
ECIA CHAPTER II	5,334,320	2,278,080	2,008,750	-3,325,570
HANDICAPPED	4,578,318	4,665,338	3,268,343	-1,309,975
VOCATIONAL & ADULT ED.	2,040,579	1,740,632	1,208,190	-832,388
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	619,751	153,371	12,987	-606,764
REHABILITATION SERVICES	3,011,066	3,042,017	2,042,731	-968,335
SCHOOL LUNCH	7,293,000	6,656,000	7,085,000	-208,000

NATIONAL EDUCATION ASSOCIATION

STATUS OF FEDERAL BUDGET FOR EDUCATION
SELECTED PROGRAMS BY STATE

PROGRAM	APPROPRIATION FISCAL YEAR 1981 (SCHOOL YEAR XX-XX)	SEPT 1982 CONTINUING RES. FISCAL YEAR 1982 (SCHOOL YEAR XX-XX)	PRESIDENT'S BUDGET FISCAL YEAR 1983 (SCHOOL YEAR XX-XX)	POTENTIAL DOLLAR LOSS FY81 TO FY83
DISTRICT OF COLUMBIA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	15,447,143	16,992,928	10,153,109	-5,294,034
ECIA CHAPTER II	5,081,817	2,278,080	2,008,750	-3,073,067
HANDICAPPED	3,554,368	3,697,415	2,590,256	-964,112
VOCATIONAL & ADULT ED.	2,203,316	1,934,807	1,342,969	-860,347
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	3,294,333	2,538,069	797,516	-2,496,817
REHABILITATION SERVICES	8,063,846	8,146,735	5,470,576	-2,593,270
SCHOOL LUNCH	10,120,000	9,235,000	9,831,000	-289,000
FLORIDA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	102,393,355	99,877,126	66,414,508	-35,978,847
ECIA CHAPTER II	15,189,568	1,644,774	14,499,835	-689,733
HANDICAPPED	34,645,895	36,388,634	25,492,373	-9,153,522
VOCATIONAL & ADULT ED.	29,413,750	25,317,104	17,572,853	-11,840,898
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	19,145,410	12,523,741	7,589,238	-11,556,172
REHABILITATION SERVICES	32,872,419	33,210,317	22,300,907	-10,571,512
SCHOOL LUNCH	148,449,000	135,473,000	144,206,000	-4,243,000
GEORGIA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	79,437,926	76,907,786	52,908,075	-26,529,851
ECIA CHAPTER II	12,412,579	1,129,928	9,983,382	-2,429,197
HANDICAPPED	25,939,632	27,401,978	19,196,693	-6,742,939
VOCATIONAL & ADULT ED.	20,674,372	17,583,388	12,204,804	-8,469,568
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	9,936,107	5,551,675	2,010,657	-7,925,450
REHABILITATION SERVICES	23,596,495	23,839,045	16,008,047	-7,588,448
SCHOOL LUNCH	116,450,000	106,271,000	113,122,000	-3,328,000
HAWAII				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	8,524,836	7,446,271	5,703,610	-2,821,226
ECIA CHAPTER II	2,614,896	2,278,080	2,008,750	-606,146
HANDICAPPED	3,010,397	3,146,939	2,204,615	-805,782
VOCATIONAL & ADULT ED.	3,021,560	2,578,568	1,789,809	-1,231,751
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	13,373,232	10,363,591	7,938,544	-5,434,688
REHABILITATION SERVICES	3,029,626	3,060,768	2,055,322	-974,304
SCHOOL LUNCH	17,372,000	15,854,000	16,876,000	-496,000

STATUS OF FEDERAL BUDGET FOR EDUCATION
SELECTED PROGRAMS BY STATE

PROGRAM	APPROPRIATION FISCAL YEAR 1981 (SCHOOL YEAR XX-XX)	SEPT 1982 CONTINUING RES. FISCAL YEAR 1982 (SCHOOL YEAR XX-XX)	PRESIDENT'S BUDGET FISCAL YEAR 1983 (SCHOOL YEAR XX-XX)	POTENTIAL DOLLAR LOSS FY81 TO FY83
IDAHO				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	9,605,249	9,313,591	6,293,389	-3,311,860
ECIA CHAPTER II	2,352,502	2,278,080	2,008,750	-343,752
HANDICAPPED	3,890,345	4,105,926	2,876,442	-1,013,903
VOCATIONAL & ADULT ED.	3,395,970	2,901,390	2,013,883	-1,382,087
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	4,607,540	3,418,897	2,302,957	-2,304,583
REHABILITATION SERVICES	3,774,304	3,813,100	2,560,517	-1,213,787
SCHOOL LUNCH	11,453,000	10,452,000	11,126,000	-327,000
ILLINOIS				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	115,817,766	134,048,626	75,481,254	-40,336,512
ECIA CHAPTER II	22,001,556	22,051,814	19,445,251	-2,556,305
HANDICAPPED	72,582,976	76,152,405	53,349,228	-19,233,748
VOCATIONAL & ADULT ED.	33,393,178	28,358,762	19,684,098	-13,709,079
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	12,655,213	7,467,626	4,899,947	-7,755,266
REHABILITATION SERVICES	31,062,245	31,381,536	21,072,870	-9,989,375
SCHOOL LUNCH	129,055,000	117,774,000	125,367,000	-3,688,000
INDIANA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	36,425,459	37,950,518	24,423,909	-12,001,550
ECIA CHAPTER II	13,296,399	11,025,907	9,723,971	-3,572,428
HANDICAPPED	24,269,089	25,400,370	17,794,450	-6,474,639
VOCATIONAL & ADULT ED.	18,654,139	15,955,828	11,075,098	-7,579,040
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	2,463,101	1,308,058	797,448	-1,665,653
REHABILITATION SERVICES	19,000,000	19,195,303	12,889,749	-6,110,251
SCHOOL LUNCH	63,826,000	58,247,000	62,002,000	-1,824,000
IOWA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	25,145,482	24,514,633	17,174,389	-7,971,093
ECIA CHAPTER II	5,003,104	5,558,515	4,898,205	-104,899
HANDICAPPED	14,321,154	15,124,531	10,595,621	-3,725,533
VOCATIONAL & ADULT ED.	9,606,829	8,012,372	5,561,467	-4,045,362
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	564,952	334,362	219,586	-345,366
REHABILITATION SERVICES	10,186,889	10,291,601	6,910,865	-3,276,024
SCHOOL LUNCH	36,686,000	33,479,000	35,638,000	-1,048,000

STATUS OF FEDERAL BUDGET FOR EDUCATION
SELECTED PROGRAMS BY STATE

PROGRAM	APPROPRIATION FISCAL YEAR 1981 (SCHOOL YEAR XX-XX)	SEPT 1982 CONTINUING RES. FISCAL YEAR 1982 (SCHOOL YEAR XX-XX)	PRESIDENT'S BUDGET FISCAL YEAR 1983 (SCHOOL YEAR XX-XX)	POTENTIAL DOLLAR LOSS FY81 TO FY83
KANSAS				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	22,180,482	21,999,521	15,114,888	-7,065,594
ECIA CHAPTER II	3,998,761	4,282,790	3,794,365	-204,396
HANDICAPPED	9,846,629	10,345,227	7,247,439	-2,599,190
VOCATIONAL & ADULT ED.	7,550,349	6,221,570	4,318,453	-3,231,896
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	7,051,912	5,451,476	4,021,078	-3,030,834
REHABILITATION SERVICES	8,109,200	8,192,555	5,501,345	-2,607,855
SCHOOL LUNCH	25,955,000	23,686,000	25,213,000	-742,000
KENTUCKY				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	58,217,910	56,723,400	38,725,855	-19,492,055
ECIA CHAPTER II	5,886,713	7,335,418	6,485,385	598,672
HANDICAPPED	16,624,240	17,523,708	12,276,386	-4,347,854
VOCATIONAL & ADULT ED.	14,220,893	12,253,082	8,504,986	-5,715,907
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	2,221,491	671,799	64,341	-2,157,150
REHABILITATION SERVICES	17,650,423	17,831,853	11,974,185	-5,676,238
SCHOOL LUNCH	66,801,000	60,962,000	64,892,000	-1,909,000
LOUISIANA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	85,601,081	84,641,949	56,767,930	-28,833,151
ECIA CHAPTER II	11,553,890	8,884,512	7,852,015	-3,701,875
HANDICAPPED	20,405,447	21,335,495	14,946,766	-5,458,681
VOCATIONAL & ADULT ED.	16,425,339	13,653,976	9,477,360	-6,947,979
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	5,750,239	3,247,239	2,101,906	-3,648,333
REHABILITATION SERVICES	20,079,799	20,286,201	13,622,293	-6,457,506
SCHOOL LUNCH	94,337,000	86,091,000	91,641,000	-2,696,000
MAINE				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	13,075,167	13,208,838	8,660,680	-4,414,487
ECIA CHAPTER II	2,465,710	2,278,080	2,008,750	-456,960
HANDICAPPED	6,190,241	6,494,858	4,550,029	-1,640,212
VOCATIONAL & ADULT ED.	4,378,149	3,657,336	2,538,593	-1,839,555
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	3,136,115	2,259,083	1,656,944	-1,479,171
REHABILITATION SERVICES	5,457,634	5,513,733	3,702,502	-1,755,132
SCHOOL LUNCH	20,080,000	18,325,000	19,506,000	-574,000

STATUS OF FEDERAL BUDGET FOR EDUCATION
SELECTED PROGRAMS BY STATE

PROGRAM	APPROPRIATION FISCAL YEAR 1981 (SCHOOL YEAR XX-XX)	SEPT 1982 CONTINUING RES. FISCAL YEAR 1982 (SCHOOL YEAR XX-XX)	PRESIDENT'S BUDGET FISCAL YEAR 1983 (SCHOOL YEAR XX-XX)	POTENTIAL DOLLAR LOSS FY81 TO FY83
MARYLAND				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	47,969,929	46,281,394	31,601,347	-16,368,582
ECIA CHAPTER II	7,231,962	8,246,650	7,256,094	24,132
HANDICAPPED	24,084,739	25,293,264	17,719,416	-6,365,323
VOCATIONAL & ADULT ED.	13,244,312	10,965,516	7,611,273	-5,633,039
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	17,929,475	10,298,945	6,504,162	-11,425,313
REHABILITATION SERVICES	12,873,529	13,005,857	8,733,503	-4,140,026
SCHOOL LUNCH	49,469,000	45,145,000	48,055,000	-1,414,000
MASSACHUSETTS				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	57,639,244	62,509,569	37,220,060	-20,419,184
ECIA CHAPTER II	10,653,970	10,615,853	9,348,015	-1,305,955
HANDICAPPED	39,033,664	40,388,982	28,294,852	-10,738,812
VOCATIONAL & ADULT ED.	18,844,759	15,394,750	10,685,649	-8,159,110
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	7,724,776	4,174,665	2,699,725	-5,025,051
REHABILITATION SERVICES	20,352,575	20,561,781	13,807,346	-6,545,229
SCHOOL LUNCH	73,136,000	66,743,000	71,046,000	-2,090,000
MICHIGAN				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	122,241,573	108,966,343	80,497,318	-41,744,255
ECIA CHAPTER II	20,542,592	18,999,187	16,752,683	-3,789,909
HANDICAPPED	41,183,021	42,859,508	30,025,600	-11,157,421
VOCATIONAL & ADULT ED.	28,985,768	24,332,764	16,889,613	-12,096,155
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	6,176,755	4,199,499	3,050,765	-3,125,990
REHABILITATION SERVICES	29,950,273	30,258,134	20,318,500	-9,631,773
SCHOOL LUNCH	100,744,000	91,938,000	97,865,000	-2,879,000
MINNESOTA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	38,576,402	37,336,406	26,008,685	-12,567,717
ECIA CHAPTER II	6,610,381	7,973,280	7,010,764	400,383
HANDICAPPED	18,890,847	19,964,260	13,986,136	-4,904,711
VOCATIONAL & ADULT ED.	13,513,811	11,165,159	7,749,847	-5,763,964
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	4,494,658	3,122,538	2,282,292	-2,212,366
REHABILITATION SERVICES	14,915,688	15,069,008	10,118,920	-4,796,768
SCHOOL LUNCH	48,706,000	44,449,000	47,314,000	-1,392,000

STATUS OF FEDERAL BUDGET FOR EDUCATION
SELECTED PROGRAMS BY STATE

PROGRAM	APPROPRIATION FISCAL YEAR 1981 (SCHOOL YEAR XX-XX)	SEPT 1982 CONTINUING RES. FISCAL YEAR 1982 (SCHOOL YEAR XX-XX)	PRESIDENT'S BUDGET FISCAL YEAR 1983 (SCHOOL YEAR XX-XX)	POTENTIAL DOLLAR LOSS FY81 TO FY83
MISSISSIPPI				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	70,264,384	66,815,959	46,662,471	-23,601,913
ECIA CHAPTER II	7,674,512	5,512,953	4,855,030	-2,819,482
HANDICAPPED	10,735,438	11,335,630	7,941,274	-2,794,164
VOCATIONAL & ADULT ED.	10,269,409	8,641,645	5,998,252	-4,271,157
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	4,055,732	2,558,902	1,516,408	-2,539,324
REHABILITATION SERVICES	14,810,174	14,962,409	10,047,338	-4,762,836
SCHOOL LUNCH	67,272,000	61,392,000	65,349,000	-1,923,000
MISSOURI				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	51,345,849	50,558,276	34,182,490	-17,163,359
ECIA CHAPTER II	17,567,404	9,249,005	8,173,497	-9,393,907
HANDICAPPED	23,895,816	25,180,010	17,640,075	-6,255,741
VOCATIONAL & ADULT ED.	17,125,996	14,313,473	9,935,123	-7,190,872
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	5,826,655	3,454,725	2,317,901	-3,508,754
REHABILITATION SERVICES	20,061,991	20,268,210	13,610,212	-6,451,779
SCHOOL LUNCH	66,876,000	61,030,000	64,965,000	-1,911,000
MONTANA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	10,022,213	9,708,327	6,710,915	-3,311,298
ECIA CHAPTER II	2,444,590	2,278,080	2,008,750	-435,840
HANDICAPPED	3,281,828	6,599,495	4,623,333	1,341,505
VOCATIONAL & ADULT ED.	2,953,523	2,435,999	1,690,851	-1,262,672
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	12,537,956	10,322,741	8,115,783	-4,422,173
REHABILITATION SERVICES	3,209,551	3,242,542	2,177,385	-1,032,166
SCHOOL LUNCH	9,141,000	8,342,000	8,880,000	-261,000
NEBRASKA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	15,712,544	14,614,789	10,672,214	-5,040,330
ECIA CHAPTER II	3,728,418	2,961,504	2,629,112	-1,099,306
HANDICAPPED	7,206,792	7,611,224	5,332,109	-1,874,683
VOCATIONAL & ADULT ED.	5,338,041	4,404,151	3,056,965	-2,281,075
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	8,345,723	6,612,999	4,357,907	-3,987,816
REHABILITATION SERVICES	5,681,507	5,739,908	3,854,379	-1,827,128
SCHOOL LUNCH	18,644,000	17,014,000	18,111,000	-533,000

STATUS OF FEDERAL BUDGET FOR EDUCATION
SELECTED PROGRAMS BY STATE

PROGRAM	APPROPRIATION FISCAL YEAR 1981 (SCHOOL YEAR XX-XX)	SEPT 1982 CONTINUING RES. FISCAL YEAR 1982 (SCHOOL YEAR XX-XX)	PRESIDENT'S BUDGET FISCAL YEAR 1983 (SCHOOL YEAR XX-XX)	POTENTIAL DOLLAR LOSS FY81 TO FY83
NEVADA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	4,523,099	4,585,507	2,914,758	-1,608,341
ECIA CHAPTER II	1,700,010	2,278,080	2,008,750	308,740
HANDICAPPED	2,875,700	3,015,919	2,112,828	-762,872
VOCATIONAL & ADULT ED.	2,124,374	1,932,183	1,341,147	-783,227
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	4,759,910	3,339,452	2,389,938	-2,369,972
REHABILITATION SERVICES	3,022,085	3,053,149	2,050,206	-971,879
SCHOOL LUNCH	7,950,000	7,255,000	7,723,000	-227,000
NEW HAMPSHIRE				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	4,445,401	5,492,561	2,908,668	-1,536,733
ECIA CHAPTER II	2,117,783	2,278,080	2,008,750	-109,033
HANDICAPPED	3,619,316	3,692,588	2,586,875	-1,032,441
VOCATIONAL & ADULT ED.	3,218,888	2,726,973	1,892,819	-1,326,069
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	1,880,330	1,338,264	1,008,610	-871,720
REHABILITATION SERVICES	3,666,980	3,704,673	2,487,708	-1,179,272
SCHOOL LUNCH	9,945,000	9,076,000	9,661,000	-284,000
NEW JERSEY				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	69,735,128	67,674,788	45,488,431	-24,246,697
ECIA CHAPTER II	15,530,875	14,032,973	12,382,265	-3,148,610
HANDICAPPED	39,171,765	41,071,664	28,773,111	-10,398,654
VOCATIONAL & ADULT ED.	21,293,990	17,561,150	12,189,369	-9,104,621
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	10,407,627	6,406,873	4,259,952	-6,147,675
REHABILITATION SERVICES	20,641,649	20,853,826	14,003,456	-6,638,193
SCHOOL LUNCH	87,909,000	80,225,000	85,397,000	-2,512,000
NEW MEXICO				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	25,401,967	24,652,736	16,922,610	-8,479,357
ECIA CHAPTER II	3,514,388	2,779,257	2,448,892	-1,065,496
HANDICAPPED	5,562,443	5,877,588	4,117,595	-1,444,848
VOCATIONAL & ADULT ED.	5,018,476	4,316,876	2,996,386	-2,022,090
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	26,806,997	22,012,229	16,878,098	-9,928,899
REHABILITATION SERVICES	6,268,043	6,332,473	4,252,289	-2,015,754
SCHOOL LUNCH	26,277,000	23,980,000	25,526,000	-751,000

STATUS OF FEDERAL BUDGET FOR EDUCATION
SELECTED PROGRAMS BY STATE

PROGRAM	APPROPRIATION FISCAL YEAR 1981 (SCHOOL YEAR XX-XX)	SEPT 1982 CONTINUING RES. FISCAL YEAR 1982 (SCHOOL YEAR XX-XX)	PRESIDENT'S BUDGET FISCAL YEAR 1983 (SCHOOL YEAR XX-XX)	POTENTIAL DOLLAR LOSS FY81 TO FY83
NEW YORK				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	243,278,164	241,595,913	158,138,195	-85,139,969
ECIA CHAPTER II	48,291,827	32,667,667	28,793,072	-19,498,755
HANDICAPPED	63,384,363	65,588,301	45,948,453	-17,435,910
VOCATIONAL & ADULT ED.	54,902,145	45,116,362	31,315,714	-23,586,430
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	29,485,554	11,491,481	5,196,916	-24,288,638
REHABILITATION SERVICES	53,742,695	54,295,121	36,459,465	-17,283,230
SCHOOL LUNCH	251,454,000	229,474,000	244,267,000	-7,187,000
NORTH CAROLINA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	88,906,141	87,836,247	59,426,588	-29,479,553
ECIA CHAPTER II	10,689,571	11,527,085	10,151,272	-538,299
HANDICAPPED	28,009,196	29,504,919	20,669,927	-7,339,269
VOCATIONAL & ADULT ED.	22,896,481	19,541,281	13,563,797	-9,332,684
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	9,640,683	5,873,570	2,478,250	-7,162,433
REHABILITATION SERVICES	27,199,694	27,479,282	18,452,486	-8,747,208
SCHOOL LUNCH	120,976,000	110,401,000	117,518,000	-3,458,000
NORTH DAKOTA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	8,722,735	8,117,759	5,875,368	-2,847,367
ECIA CHAPTER II	1,951,219	2,278,080	2,008,750	57,531
HANDICAPPED	2,288,945	2,400,806	1,681,905	-607,040
VOCATIONAL & ADULT ED.	2,630,977	2,309,146	1,602,801	-1,028,176
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	7,316,082	6,001,667	4,699,598	-2,616,484
REHABILITATION SERVICES	3,032,863	3,064,038	2,057,518	-975,345
SCHOOL LUNCH	8,717,000	7,955,000	8,468,000	-249,000
OHIO				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	84,164,321	88,275,957	55,664,609	-28,499,712
ECIA CHAPTER II	25,208,194	21,231,706	18,703,408	-6,504,786
HANDICAPPED	50,551,084	52,998,929	37,128,860	-13,422,224
VOCATIONAL & ADULT ED.	35,533,013	29,727,623	20,634,238	-14,898,775
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	7,118,559	3,181,969	1,407,152	-5,711,407
REHABILITATION SERVICES	40,827,500	41,247,169	27,697,696	-13,129,804
SCHOOL LUNCH	131,050,000	119,595,000	127,305,000	-3,745,000

STATUS OF FEDERAL BUDGET FOR EDUCATION
SELECTED PROGRAMS BY STATE

PROGRAM	APPROPRIATION FISCAL YEAR 1981 (SCHOOL YEAR XX-XX)	SEPT 1982 CONTINUING RES. FISCAL YEAR 1982 (SCHOOL YEAR XX-XX)	PRESIDENT'S BUDGET FISCAL YEAR 1983 (SCHOOL YEAR XX-XX)	POTENTIAL DOLLAR LOSS FY81 TO FY83
OKLAHOMA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	36,524,477	35,446,385	24,431,986	-12,092,491
ECIA CHAPTER II	5,085,337	5,695,200	5,039,644	-45,693
HANDICAPPED	15,084,535	15,889,306	11,131,599	-3,952,936
VOCATIONAL & ADULT ED.	10,331,247	8,701,726	6,039,955	-4,291,293
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	21,317,962	16,939,689	12,257,142	-9,060,820
REHABILITATION SERVICES	12,845,425	12,977,464	8,714,437	-4,130,988
SCHOOL LUNCH	43,881,000	40,045,000	42,627,000	-1,254,000
OREGON				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	28,225,452	30,034,779	18,806,053	-9,419,399
ECIA CHAPTER II	4,296,691	4,829,530	4,255,786	-40,905
HANDICAPPED	12,615,717	13,021,773	9,122,516	-3,493,201
VOCATIONAL & ADULT ED.	7,908,536	6,825,720	4,737,800	-3,170,736
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	2,851,482	1,789,287	1,261,181	-1,590,301
REHABILITATION SERVICES	9,114,532	9,208,221	6,183,370	-2,931,162
SCHOOL LUNCH	31,021,000	28,309,000	30,134,000	-887,000
PENNSYLVANIA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	119,568,418	122,023,320	78,967,329	-40,601,089
ECIA CHAPTER II	20,340,163	21,869,568	19,264,407	-1,075,756
HANDICAPPED	51,580,355	53,701,637	37,621,148	-13,959,207
VOCATIONAL & ADULT ED.	39,413,896	32,840,733	22,795,079	-16,618,815
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	7,614,026	2,825,011	1,118,902	-6,495,124
REHABILITATION SERVICES	44,552,294	45,010,251	30,224,625	-14,327,669
SCHOOL LUNCH	140,419,000	128,145,000	136,406,000	-4,013,000
RHODE ISLAND				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	9,894,896	9,440,120	6,651,613	-3,243,283
ECIA CHAPTER II	2,807,257	2,278,080	2,008,750	-798,507
HANDICAPPED	4,293,020	4,508,139	3,158,216	-1,134,804
VOCATIONAL & ADULT ED.	3,440,630	2,896,379	2,010,406	-1,430,225
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	2,433,409	1,718,273	1,197,794	-1,235,615
REHABILITATION SERVICES	3,632,281	3,669,618	2,464,168	-1,168,113
SCHOOL LUNCH	10,585,000	9,660,000	10,282,000	-303,000

STATUS OF FEDERAL BUDGET FOR EDUCATION
SELECTED PROGRAMS BY STATE

PROGRAM	APPROPRIATION FISCAL YEAR 1981 (SCHOOL YEAR XX-XX)	SEPT 1982 CONTINUING RES. FISCAL YEAR 1982 (SCHOOL YEAR XX-XX)	PRESIDENT'S BUDGET FISCAL YEAR 1983 (SCHOOL YEAR XX-XX)	POTENTIAL DOLLAR LOSS FY81 TO FY83
SOUTH CAROLINA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	54,397,682	52,355,448	36,378,996	-18,018,686
ECIA CHAPTER II	6,436,972	6,469,747	5,700,367	-736,605
HANDICAPPED	16,190,040	17,109,853	11,986,456	-4,203,584
VOCATIONAL & ADULT ED.	12,864,000	10,867,122	7,542,977	-5,321,023
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	8,343,741	5,626,362	3,585,917	-4,757,824
REHABILITATION SERVICES	15,422,853	15,581,386	10,462,984	-4,959,869
SCHOOL LUNCH	68,431,000	62,449,000	66,475,000	-1,956,000
SOUTH DAKOTA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	9,080,210	9,171,441	6,188,542	-2,891,668
ECIA CHAPTER II	2,003,848	2,278,080	2,008,750	4,902
HANDICAPPED	2,511,846	2,630,192	1,842,604	-669,242
VOCATIONAL & ADULT ED.	2,783,811	2,442,215	1,695,166	-1,088,646
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	14,488,157	12,535,861	9,861,639	-4,626,518
REHABILITATION SERVICES	3,144,743	3,177,068	2,133,418	-1,011,325
SCHOOL LUNCH	11,618,000	10,602,000	11,286,000	-332,000
TENNESSEE				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	64,660,316	61,882,435	42,916,265	-21,744,051
ECIA CHAPTER II	7,862,551	8,930,074	7,882,990	20,439
HANDICAPPED	22,113,851	23,375,425	16,375,857	-5,737,994
VOCATIONAL & ADULT ED.	17,460,441	14,873,163	10,323,610	-7,136,831
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	6,326,286	2,702,220	760,866	-5,565,420
REHABILITATION SERVICES	21,458,904	21,679,482	14,557,889	-6,901,015
SCHOOL LUNCH	78,366,000	71,516,000	76,126,000	-2,240,000
TEXAS				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	239,495,463	234,951,112	155,948,811	-83,546,652
ECIA CHAPTER II	27,272,790	28,840,493	25,427,459	-1,845,331
HANDICAPPED	67,490,209	69,099,906	48,408,539	-19,081,670
VOCATIONAL & ADULT ED.	47,306,142	39,922,668	27,710,720	-19,595,422
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	30,397,248	19,112,169	11,546,210	-18,851,038
REHABILITATION SERVICES	52,320,079	52,857,881	35,494,352	-16,825,727
SCHOOL LUNCH	144,147	*	*	*

STATUS OF FEDERAL BUDGET FOR EDUCATION
SELECTED PROGRAMS BY STATE

PROGRAM	APPROPRIATION FISCAL YEAR 1981 (SCHOOL YEAR XX-XX)	SEPT 1982 CONTINUING RES. FISCAL YEAR 1982 (SCHOOL YEAR XX-XX)	PRESIDENT'S BUDGET FISCAL YEAR 1983 (SCHOOL YEAR XX-XX)	POTENTIAL DOLLAR LOSS FY81 TO FY83
UTAH				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	9,319,311	9,169,164	6,305,867	-3,013,444
ECIA CHAPTER II	3,003,797	3,234,874	2,838,377	-165,420
HANDICAPPED	8,397,809	8,854,627	6,203,186	-2,194,623
VOCATIONAL & ADULT ED.	5,413,548	4,635,771	3,217,735	-2,195,814
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	7,076,129	5,256,447	2,763,324	-4,312,805
REHABILITATION SERVICES	6,233,988	6,298,068	4,229,186	-2,004,802
SCHOOL LUNCH	21,079,000	19,236,000	20,477,000	-602,000
VERMONT				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	4,896,071	5,484,494	3,199,103	-1,696,968
ECIA CHAPTER II	1,809,738	2,278,080	2,008,750	199,012
HANDICAPPED	3,487,760	3,572,087	2,502,457	-985,303
VOCATIONAL & ADULT ED.	2,096,835	1,798,567	1,248,404	-848,431
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	73,875	7,057	1,300	-72,575
REHABILITATION SERVICES	3,000,000	3,030,837	2,035,224	-964,776
SCHOOL LUNCH	6,461,000	5,896,000	6,276,000	-185,000
VIRGINIA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	58,196,376	59,787,149	39,233,779	-18,962,597
ECIA CHAPTER II	11,701,345	10,251,360	9,027,823	-2,673,522
HANDICAPPED	23,310,087	24,543,240	17,193,980	-6,116,107
VOCATIONAL & ADULT ED.	18,367,049	15,412,164	10,697,736	-7,669,313
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	32,879,184	21,572,093	10,724,290	-22,154,894
REHABILITATION SERVICES	19,593,654	19,795,059	13,292,488	-6,301,166
SCHOOL LUNCH	76,335,000	69,663,000	74,153,000	-2,182,000
WASHINGTON				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	42,577,473	42,934,073	28,054,790	-14,522,683
ECIA CHAPTER II	9,658,260	7,654,349	6,752,188	-2,906,072
HANDICAPPED	15,691,256	16,811,327	11,777,321	-3,913,935
VOCATIONAL & ADULT ED.	11,977,352	10,041,306	6,969,770	-5,007,582
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	19,908,535	14,639,300	9,557,355	-10,351,180
REHABILITATION SERVICES	12,451,994	12,579,989	8,447,530	-4,004,464
SCHOOL LUNCH	41,068,000	37,478,000	39,894,000	-1,174,000

STATUS OF FEDERAL BUDGET FOR EDUCATION
SELECTED PROGRAMS BY STATE

PROGRAM	APPROPRIATION FISCAL YEAR 1981 (SCHOOL YEAR XX-XX)	SEPT 1982 CONTINUING RES. FISCAL YEAR 1982 (SCHOOL YEAR XX-XX)	PRESIDENT'S BUDGET FISCAL YEAR 1983 (SCHOOL YEAR XX-XX)	POTENTIAL DOLLAR LOSS FY81 TO FY83
WEST VIRGINIA				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	28,894,177	28,169,032	19,560,043	-9,334,134
ECIA CHAPTER II	3,282,349	3,827,174	3,356,453	74,104
HANDICAPPED	8,494,972	8,968,539	6,282,988	-2,211,984
VOCATIONAL & ADULT ED.	7,262,243	6,202,536	4,305,242	-2,957,002
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	366,414	114,854	39,783	-326,631
REHABILITATION SERVICES	12,437,159	12,565,002	8,437,466	-3,999,693
SCHOOL LUNCH	32,502,000	29,661,000	31,573,000	-929,000
WISCONSIN				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	44,264,702	41,535,259	29,691,383	-14,573,319
ECIA CHAPTER II	13,788,358	9,294,566	8,194,484	-5,593,874
HANDICAPPED	17,269,928	18,100,067	12,680,159	-4,589,769
VOCATIONAL & ADULT ED.	16,313,868	13,439,561	9,328,533	-6,985,335
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	4,754,360	3,690,052	2,785,975	-1,968,385
REHABILITATION SERVICES	18,720,121	18,912,547	12,699,877	-6,020,244
SCHOOL LUNCH	50,514,000	46,099,000	49,070,000	-1,444,000
WYOMING				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	4,381,441	4,838,086	2,883,223	-1,498,218
ECIA CHAPTER II	1,743,256	2,278,080	2,008,750	265,494
HANDICAPPED	2,935,130	3,040,799	2,130,258	-804,872
VOCATIONAL & ADULT ED.	1,491,826	1,318,289	915,037	-576,789
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	5,323,038	4,197,761	2,834,792	-2,488,246
REHABILITATION SERVICES	3,015,638	3,046,636	2,045,832	-969,806
SCHOOL LUNCH	3,815,000	3,482,000	3,706,000	-109,000
U. S. TOTAL				
FORWARD FUNDED PROGRAMS...	(SY 81-82)	(SY 82-83)	(SY 83-84)	
ECIA CHAPTER I	2,951,692,000	2,887,449,000	1,942,000,000	-1,009,692,000
ECIA CHAPTER II	512,010,000	455,616,000	406,080,000	-105,930,000
HANDICAPPED	1,027,150,000	1,101,528,000	771,685,000	-255,465,000
VOCATIONAL & ADULT ED.	760,501,000	639,716,000	444,033,223	-316,467,777
CURRENT FUNDED PROGRAMS...	(SY 80-81)	(SY 81-82)	(SY 82-83)	
IMPACT AID	619,400,000	417,600,000	275,080,000	-344,320,000
REHABILITATION SERVICES	854,259,000	863,040,000	579,536,000	-274,723,000
SCHOOL LUNCH	3,305,975,000	3,017,000,000	3,211,490,000	-94,485,000

STATUS OF FEDERAL BUDGET FOR EDUCATION
SELECTED PROGRAMS BY STATE

PROGRAM	APPROPRIATION FISCAL YEAR 1981 (SCHOOL YEAR XX-XX)	SEPT 1982 CONTINUING RES. FISCAL YEAR 1982 (SCHOOL YEAR XX-XX)	PRESIDENT'S BUDGET FISCAL YEAR 1983 (SCHOOL YEAR XX-XX)	POTENTIAL DOLLAR LOSS FY81 TO FY83

ECIA CHAPTER I. SOURCE: FY81 - US DEPT ED; FY82 - STATE AMOUNTS ESTIMATED BY NEA RESEARCH BASED ON FY81 STATE DISTRIBUTION AND DEPT ED US TOTAL; FY83 - US DEPT ED.

ECIA CHAPTER II. SOURCE: FY81 - US DEPT ED; FY82 - STATE AMOUNTS ESTIMATED BY NEA RESEARCH BASED ON FY81 STATE DISTRIBUTION AND DEPT ED US TOTAL; FY83 - US DEPT ED.

EDUCATION FOR THE HANDICAPPED. INCLUDES: STATE GRANT PROGRAM; PRESCHOOL INCENTIVE GRANTS, CHAPTER I HANDICAPPED
SOURCE: FY81 - US DEPT ED; FY82 AND FY83 AMOUNTS ESTIMATED BY NEA RESEARCH BASED ON FY81 STATE DISTRIBUTION AND DEPT ED US TOTALS

VOCATIONAL AND ADULT EDUCATION. INCLUDES: BASIC GRANTS, PROGRAM IMPROVEMENT, DISADVANTAGED, CONSUMER AND HOMEMAKING, STATE PLANNING AND EVALUATION, ADULT EDUCATION GRANTS TO STATES
SOURCE: FY81 AND FY82 - US DEPT ED; FY83 - STATE AMOUNTS ESTIMATED BY NEA RESEARCH BASED ON FY82 STATE DISTRIBUTION AND DEPT ED US TOTALS

IMPACT AID (PL81-874). INCLUDES: MAINTENANCE AND OPERATIONS PAYMENTS FOR "A" AND "B" CHILDREN (SECTIONS 3A AND 3B).
SOURCE: FY81-FY83: US DEPT ED

REHABILITATION SERVICES AND HANDICAPPED RESEARCH. INCLUDES: BASIC STATE GRANTS.
SOURCE: FY81 - US DEPT ED; FY82 AND FY83 - STATE AMOUNTS ESTIMATED BY NEA RESEARCH BASED ON FY81 STATE DISTRIBUTION AND DEPT ED US TOTALS

SCHOOL LUNCH. INCLUDES: SCHOOL LUNCH, SPECIAL MEAL ASSISTANCE, COMMODITIES
SOURCE: FY81 USDA, FOOD AND NUTRITION SERVICE; FY82 AND FY83 - STATE AMOUNTS ESTIMATED BY NEA RESEARCH BASED ON FY81 STATE DISTRIBUTION AND DEP ED US TOTALS.

DETAIL MAY NOT ADD TO TOTAL DUE TO ROUNDING. IN ADDITION, US TOTALS INCLUDE AMOUNTS NOT SHOWN FOR AREAS OUTSIDE THE US (AMERICAN SAMOA, GUAM, PUERTO RICO, TRUST TERRITORY, VIRGIN ISLANDS, NORTHERN MARIANAS).

Source: NEA Research, 1982

Chairman PERKINS. Thank you very much for an excellent statement.

Our next witness is Mr. Harold Raynolds, commissioner of education and cultural services in the State of Maine. We are delighted to welcome you.

STATEMENT OF HAROLD RAYNOLDS, COMMISSIONER OF EDUCATION, STATE OF MAINE, REPRESENTING THE COUNCIL OF CHIEF STATE SCHOOL OFFICERS

Mr. RAYNOLDS. It is a pleasure to be here.

I feel I am on a mission of making common cause from the northland because this bill represents a direction which we have been in before, as you know so well, Mr. Chairman, but have strayed from, in my opinion, in the last several years, and that is the enunciation, the identification, the perception at the national level by those who lead us at the national level of the very serious needs we have in education and in so doing, suggesting some of those important priorities for the Nation with regard to the development of education.

So I am here on a mission of common cause. I am Harold Raynolds, commissioner of education for the State of Maine, here representing the council of chief State school officers. The council is an independent organization composed of the commissioners and superintendents of education from each of the 50 States, 6 extraterritorial jurisdictions, and the District of Columbia.

I am not going to read my testimony. I will point to the places that I think are very important in it.

I would like to carry for a moment or two the theme that I tried to start with, my concern for the assistance and the direction of the national Government acting, of course through the Congress, to identify those things which have high national priority.

How can a Nation with 6 percent of the population of the world dropping to 4 percent by the year 2000 survive, lead, without recognizing what a most important resource we have.

I had the good chance last night to watch public television's Nova performance. This week in Maine it was a man, whom I have met, who is a Nobel laureate, Richard Feinman. He spoke for an hour about his own experiences as a scientist. He had an opportunity which I am not sure all the children in the United States have, to explore, to play, to develop his mind around and about ideas.

It was a very, very powerful performance. It suggested that he was communicating the joys of finding things out. He was inventive, creative, a delightful kind of free play of the mind for an hour. He has a special way of looking at things, just as math, science, and foreign languages provide us with a special way of looking at things.

I am suggesting as a result of that little aside that the national need is incredible. I have read and heard much about capital formation, particularly during the last several hours, but throughout our national history we have heard about capital formation. I suggest that your bill is an important step toward intellectual capital formation, which is in my judgment more important than the other kind of capital formation, because the other will not have the significance that it should have if we haven't formed our intellectual capitalization.

I will move to certain segments of my testimony to which I would like to call your attention. My purpose is to summarize the views of the council of chief State school officers regarding the national crisis we face in math, science, foreign language, and technology education, and to provide some specific reactions to this particular bill.

The council believes that the problems of improving mathematics and science and foreign language instruction can be most effectively addressed at the national level by Federal action. We provide a number of other comments through here, but I am going to page 6 in this and pick up on some of the short-term issues which I want to identify and which you have already come on through your consideration of this legislation.

The first, and it has already been referred to by a number of others testifying before me, is the question of teacher supply, and I want to underline a word which has not always been attached to that, that is teacher quality. Supply is not sufficient, even if solved, unless we have addressed very carefully the question of quality.

The second short range issue of real concern is equity and excellence. There is no excellence without equity. I am very much concerned that this bill will help all young people—all young people become scientifically literate and mathematically competent. And an issue which you have discussed, the question of going either the road of dividing all of the different groups, sometimes referred to as the turf problem or trying to find a way to bring people together to make that common cause from all of their different perspectives.

That is the effective school movement which is now widespread throughout the United States, and there is my third concern, can we concentrate on efforts to collaborate to bring together those various resources.

I want to return to some specific suggestions, my page 7. Fortunately, Members of Congress, including specifically the chairman and members of this committee, have recognized the scope and nature of the problems we face. We have identified several outstanding issues raised by the bill as presently drafted, and I want to offer a couple of recommendations with the full understanding that there are staff members and members of the council of chief State school officers who would be happy to try to help amplify, discuss, relate, work on these recommendations.

One, under the legislation as drafted, the limited funds authorized would be likely to be too diffused to accomplish the purposes of the bill. With that in mind, I suggest there are some other possibilities for concentrating those funds.

One would be a competitive grants model. Another would be a model leveraging funds through in-kind matching and insensitive bonuses. A third would be a change in the distribution of funds. One method for increasing the targeting of the funds in areas of greatest need while still insuring that all would participate would be to reserve a larger portion of the funds at the State level.

Here again is an old turf issue, State or local level. I raise it because I think there are possibilities for cooperation at that level and among those various groups that might raise the turf issue. Funds reserved at the State level can be earmarked for both State level activities such as insufficient teacher development and for use at the local level according to the State-developed criteria.

A fourth concern is the targeting of areas of need. We suggest that the formula could be targeted more precisely using different factors—poverty, for example, measures of the teacher shortage, for example. Whatever measures are used should be considered in light of the three major issues which I tried to identify just a moment or two ago.

We would further suggest very strongly that the provision of the current bill which calls for the Secretary of Education to develop the criteria for distributing 25 percent of the funds to local districts is totally inappropriate. This is this question of targeting.

A fifth suggestion is the use of performance and bonuses. That is another model which might be helpful in making a greater impact with the dollars that are available in this bill.

A second major issue is that limited State role. We believe that that role is inadequate to meet both the responsibilities of the States and to meet the needs addressed in the bill. The promise of programs funded under the bill to provide meaningful assistance in addressing the three fundamental issues of teacher supply and quality, coordination, and equity would be significantly increased by an enhanced State role.

This could be accomplished in a number of ways. Give States funds to coordinate with State initiatives. Give States a larger role in in-service training. How States are to conduct in-service activities directly. States provide a base for institutional coordination, particularly through such things as certification, cooperative efforts with the universities and colleges. States must help insure equity and excellence.

A third issue we think the bill in its current form may not address adequately is the issue of teacher supply and quality. Let me cite some suggestions, please. We suggest funneling a larger portion of part B funds to some other institutes. We suggest authorizing a program of fellowships for existing faculty, providing incentives to LEA's to give teachers longer contracts, as an example, of a possibility. We suggest focusing in-service teacher development on equity issues. Those are just several suggestions which meet that issue.

A fourth issue, and I have one after that, the bill should provide adequate mechanisms for accountability. You have heard things about that. We believe strongly that no activity in education should go unexamined, and that is an important factor. States should be given responsibility and authority for insuring that program quality.

It is impractical to ask the Nation's 16,000 local school systems to deal directly with the Federal Education Department. At the same time, Federal education programs must meet State and local educational and performance ability standards. We think accountability standards should take the form of performance standards and incentives.

My last and one which I have been leading to is that we are concerned that for the very considerable objective which you have laid out, the proposed level of authorizations contained in the bill is inadequate to address the problems we face.

The council recognizes the budget restraints faced by the Congress, yet the funding levels proposed in both parts A and B of this bill are insufficient to deal substantively on a nationwide basis with any of even the most basic problems we have identified.

The only suggestion we can offer is that you seriously consider increasing authorization levels contained in the bill. I realize how difficult a suggestion that really is.

By way of conclusion, then, members of the council of chief State school officers, and I in particular, want to commend the chairman, members of the committee, all those who have sponsored this bill, for addressing the very real problems we face in attempting to preserve national security and economic strength through education improvements.

I go back to where I started. The question of intellectual capital formation is the most significant activity that our schools and our educational enterprises can undertake as far as I am concerned, and for that reason we are ready to work with you and with other organizations to make sure that this major national issue is addressed effectively and thoughtfully.

Thank you very much.

[Prepared statement of Harold Raynolds follows:]

Prepared Statement of Harold Raynolds, Commissioner of Education, State of Maine, Representing the Council of Chief State School Officers

I. INTRODUCTION

Mr. Chairman, I am Harold Raynolds, Commissioner of Education for the state of Maine. I am here today representing the Council of Chief State School Officers (CCSSO). The Council is an independent organization composed of the commissioner and superintendents of education from each of the fifty states, six extra-territorial jurisdictions, and the District of Columbia. Members of the Council are the principal administrative officers of the public school systems in each state, and as such bear a heavy responsibility, along with our colleagues at the local level, for helping to insure that our children are well served by the nation's educational systems.

The purposes of my appearance today are to summarize the views of the Council regarding the national crisis we face in mathematics, science, foreign language, and technology education, and to provide some specific reactions to HR 30, including suggestions regarding ways the bill could be strengthened. The Council believes that the problems of improving mathematics and science education, and foreign language instruction can be most effectively addressed at the national level by federal action. At the same time, our comments are based on the premise that the possibly effective approaches to this national problem depend on support from every governmental level, and recognition that such solutions must address national priorities in the context of state and local needs.

II. CCSSO VIEWS THE PROBLEM

The Council's view of the dimensions of the national problem we face in mathematics/science/foreign language/technology instruction can be expressed in the form of a series of propositions which we believe can form the basis for an appropriate national policy. These propositions, supported by the rationale for each and specific recommendations, are discussed more fully in the Council's policy statement, "Need for a New 'National Defense Education Act,'" a copy of which is appended to each copy of this statement.

Proposition One: There is a federal role in support of improved instruction in mathematics and science.

During the 1980s, the United States will experience an accelerating trend toward a focus on high technology industries, while also facing the challenge of increasing our national security and revitalizing basic industries. Our future security and physical and economic well-being will depend on how well America manages the task of investing in the education of tomorrow's citizens.

Proposition Two: The elements of federal legislation should include: incentives to increase the supply and upgrade the quality of the teaching profession, funds for equipment, support for youth activities, and support for other activities.

You will hear, Mr. Chairman, throughout these hearings about the scope of the problems faced by our schools. Let me simply point out a few examples: the state of California estimates an annual need for at least 1500 additional secondary science and mathematics teachers simply to cope with existing shortages. Similarly, some school districts in Maryland are unable to find a single trained, certified physics teacher to staff existing high school programs. This story is repeated throughout the country: too few qualified teachers and too little equipment is available to teach science, mathematics and technological subjects adequately. Recent figures from the National Science Foundation indicate that, nationwide, 16 percent of all elementary school teachers are not sufficiently prepared to provide basic training in science and mathematics. At the same time, the federal government's commitment to research and training in science education has declined to almost nothing since the 1960s.

Proposition Three: Support for foreign language instruction is part of the federal role in support of education.

The Council believes that national security requires that we be able to understand major world cultures and political groups, and that trade and economic development in a global economy depend on our ability to communicate with trading partners. For these reasons, we believe steps must be taken to reverse the current decline in the foreign language proficiency of the American public. This is an appropriate area for federal support and action, as numerous members of this Committee have already indicated through the years.

Proposition Four: Federal support for math/science/technology education should be administered through states, should be coordinated with the numerous state-level initiatives in this area, and should be of sufficient scope to have a significant impact on the nation's schools.

Recent surveys by the Education Commission of the States indicate that, out of nearly forty states queried, all are implementing programs to improve educational quality. Such programs include: new science/mathematics curricula, inservice teacher training, increased use of computers in the classroom, and providing special programs to enhance teacher supply and quality. Kentucky, for example, has initiated at the state level a student loan forgiveness program for future science and mathematics teachers. At the same time, states have widely varying needs. In New York State, for example, 57 percent of high school students following an academic track take three or more years of science, while only 41 percent of such students nationally take as much science. Surveys also indicate that science teacher shortages vary by discipline and geographic area. National legislation, therefore, must provide the flexibility for state and local education agencies to be able to use funds in the areas of their own greatest needs.

Proposition Five: The federal role in the areas of math/science/foreign language/technology education is linked to the federal role in support of human capital development generally, as well as to defense preparedness through personnel preparation. Training for high technology occupations, math and science education, and defense preparedness are interrelated activities. Public school vocational-technical education programs can contribute directly to the needed manpower of the military services through specific training programs keyed to Military Occupational Specialty (MOS) needs. Both the private sector and the defense establishment can contribute to and benefit from national policies in these areas.

The number of young people is shrinking, while the needs of the nation for a better qualified technical workforce are well documented. Retraining of the existing workforce will be important, but much will depend on the types of training received by young people entering the workforce. There must be increased coordination of resources among the military, the private sector, and all levels of educational institutions. The Council has developed a number of recommendations for ways to stimulate such coordination, many of which could be applied to HR 30 and which are discussed in our statement. Others are to be found in the policy statement attached to copies of the statement.

Proposition Six: Both federal and state efforts to support improved instruction in math, science, technical fields and foreign languages should have a significant focus on increasing access and equity. The particular needs of women and minorities must be addressed in this national effort.

The Council believes that excellence in education means increased equity. Historically, women and minorities have been underrepresented in technical fields of study. For example, a 1980 estimate by the National Center for Education Statistics places the proportion of females taking three or more years of mathematics in high school at only 26 percent. Sixty percent of white students take geometry, but only 39 percent of black students do so. Women and minorities together make up more than 60 percent of the population, but a mere five to ten percent of the nation's engineers. It is part of the federal role in support of education, and the responsibilities of state and local education authorities, to find ways to take advantage of this resource.

Proposition Seven: Federal legislation to support mathematics, science, foreign language, and technical instruction must incorporate and assure an adequate level of financial support.

Previous federal efforts in the mathematics and science areas have been funded at fairly modest levels. Even the first incarnation of the National Defense Education Act was only modestly funded. The Council believes that federal education programs which in the past have been accused of "failure" have often simply been inadequately funded. A successful federal program, ECIA Chapter 1, is funded at a level which provides about $450 support for each child served. Yet, it is a targeted program which only serves about half of those eligible, and the eligible population is relatively small. We believe the level of Federal effort in support of mathematics, science, foreign language and technological instruction should be at least on the same order of magnitude as ECIA Chapter I.

The point, therefore, is that for any significant positive efforts to be realized, funding must be at the level of billions rather than millions. In addition, a program must have continuity of funding over a period of several years in order to be integrated into local and state efforts. We recognize the severe budget constraints facing the federal government, but we also must urge the Congress to recognize the scope of this national problem.

III. WHAT ARE THE MOST SIGNIFICANT SHORT-TIME ISSUES?

As I said, the Council recognizes the budget constraints facing the Congress. At the same time, we believe that both the scale and the substantive aspects of the problems we face are beyond the capacity of any single piece of legislation to confront. Therefore, we have identified what we believe to be the three most significant short-term problems in the specific area of mathematics and science instruction in elementary and secondary schools:

One: Teacher supply and quality.—Our problem is that there are simply not enough trained and qualified science and math teachers available. The lack of adequate numbers of teacher forces the use of untrained teachers. Untrained teachers, besides the possibly poorer instruction they are able to provide, help to exacerbate the problem of too few science and mathematics majors.

Two: Equity and excellence.—As I have noted, educational excellence means equity: we need new curricula which match the stages of children's intellectual development; we need new science and mathematics equipment; we need, most of all, to have the means at hand to help all young people become scientifically literate and mathematically competent.

Three: Coordination among institutions.—The problems we face are not unique to schools, and cannot be solved by state and local education agencies alone. Because the problems we face involve every part of our economy and educational structure, each level of government and social institution must help. Postsecondary educational institutions, the private sector, and government—including the military—must all be called upon to provide assistance, support, and cooperation with the schools in efforts to address these problems.

IV. SPECIFIC SUGGESTIONS ABOUT H.R. 30

Fortunately, members of Congress, including specifically the Chairman and members of this Committee, have recognized the scope and nature of the problems we face. H.R. 30 addresses, in some way, many parts of the issues which I have discussed. At the same time, we believe that the promise of the bill could be realized more effectively by adopting some of the suggestions discussed below. We have identified six outstanding issues raised by the bill as presently drafted, and offer several recommendations for ways to address each issue. We are not supporting any one of these recommendations to the exclusion of the others, but rather believe that each should be explored before the committee commits itself to one plan of legislation action.

Issue One: Under the legislation as drafted, the limited funds authorized would be likely to be too diffused to accomplish the purposes of the bill. It would enhance the prospects for success for programs under the bill if funds could be more precisely targeted to the areas of greatest need in the country, and to the aspects of the problem which are identified by states and localities as being most difficult. At least five additional possibilities, each of which would target funds more precisely on problem areas, should be considered as you develop this legislation further:

Competitive grants model.—Public Law 90-35, the Education Professions Development Act, was developed to improve the quality of teaching and to help meet critical shortages of adequately trained personnel through the identification of needs in a state plan. The bill called for a state plan to meet state needs. In many cases, these plans were administered by state education agencies through the use of competitive grants which focused funds on local areas with the greatest needs.

Matching funds model.—It is our belief that the bill could have greater impact if funds under the Act could leverage other federal, state or local funds. We think that the Committee should consider requiring matching funds from other sources in both Parts A and B of the bill. In Part A, a matching requirement of up to 50 percent would not be unreasonable, and would significantly increase the impact of funds devoted to this problem. Federal funding, such as ECIA Chapter Two, Vocational Education Act, ECIA Chapter One, and special education could be allowed to be counted as matching funds. Additionally, state and local funds or in-kind contributions, along with funds received from local business and industry, would count as matching funds.

Change the distribution of funds.—One method of increasing the targeting of the funds on areas of greatest need, while still insuring that all would participate, would be to reserve a larger proportion of the funds at the state level; a 65–35-percent division would be appropriate. Funds reserved at the state level could be earmarked for both state level activities, such as inservice teacher development efforts, and for use at the local level according to state-developed criteria.

Target the basic intrastate distribution formula.—The intrastate funds distribution formula proposed in the bill would distribute funds principally on the basis of population, but the problems are not evenly distributed. We suggest that the formula could be targeted more precisely using different factors: poverty (as a measure of the need for supplementary instructional services as in ECIA Ch. 1), or measures of the teacher shortage in particular states (where satisfactory data are available). Whatever measures are used should be considered in light of the three major issues identified above, particularly including teacher supply and quality, and equity. We would further suggest very strongly that the provision of the current bill which calls for the Secretary of Education to develop the criteria for distributing 25 percent of the funds due local districts is totally inappropriate. Nationally, the formula should distribute funds equitably among the states, and that decision must be made by the Congress and/or the Secretary. However, the decision about how best to target any portion of the funds within each state should be made by state authorities, in consultation with local authorities within that state. No federal official, no matter how well informed, can know the exact needs within any one state, and needs vary widely among states, as we have shown.

Use performance bonuses.—One way to address the need for additional coordination and cooperation among various social institutions would be to structure basic funding using a performance bonus concept. Thus, for example, if greater coordination among postsecondary institutions and local education agencies is to be desired, some Part B funds should be made contingent upon the establishment of cooperative agreements. Similarly, if an LEA were able to obtain a significant percentage of funds from local business and industry, such a district could receive a performance bonus equal to perhaps ten percent of its basic grant.

Issue Two: The limited state role laid out in the bill is inadequate to meet both the responsibilities of states and to meet the needs addressed in the bill. The promise of programs funded under the bill to provide meaningful assistance in addressing the three fundamental issues of teacher supply and quality, coordination among various institutions, and equity would be significantly increased by an enhanced state role. This could be accomplished in a variety of ways:

Give States funds to coordinate with State initiatives.—As noted above, the Education Commission of the States has surveyed the states and established that nearly all have significant state level activities proceeding in this area. States should have both the authority and the funds under this Act to coordinate federal funds with state programs.

Give States a larger role in inservice training.—In order effectively to address the questions of teacher supply and quality, it would be best to tie all inservice training efforts to standards accepted by the state (although perhaps selected by local governing boards). Moreover, in many states there are existing regional inservice teacher training and upgrading institutions maintained by state agencies. It would make sense to amend sec. 604(a)(1)(A) of the bill to provide for school districts to spend inservice funds in such regional centers.

Allow States to conduct inservice activities directly.—The bill does not appear to provide authority for state education agencies to use the funds they receive to carry out (either on their own or through contracts) programs to upgrade or retrain teachers. State education agencies can and do have the capability to mount statewide programs of innovation, and such capabilities should be encouraged and supported. Sec. 605(a) should explicitly allow SEAs to use funds to develop and conduct (or contract for) innovative projects to upgrade and train teachers, administrators, and others.

States provide a base for institutional coordination.—State education agencies and state boards of education are key links in the task of assuring coordination and cooperation among levels of government, the private sector, and postsecondary education. Therefore, the bill should provide authority and responsibility to states to ensure the development of policies and activities which increase such coordination.

States must help ensure equity and excellence.—Graduation requirements and other performance standards, policies promoting the equitable treatment of women and minorities, and the development of substantive curriculum changes are all part of the responsibilities of states, and should be recognized in the structure of the bill.

Issue Three: The bill, in its current form, may not address adequately the fundamental issue of teacher supply and quality. As I have noted, the Council believes that in the short run, one of the most significant problems we face is the supply and quality of the teaching staff necessary to accomplish the goals of increasing scientific literacy and mathematical competence. We believe the promise of the bill could be enhanced by adoption of these recommendations:

Funnel a large proportion of part B funds to summer institutes.—Experience suggests that summer institutes for science teachers, focused on both scientific subjects and pedagogy, are among the most effective ways to increase the skills of current faculty. Therefore, we suggest that a large proportion of funds under Part B should be devoted to such institutes, and that they should be operated in accordance with the goal of increased coordination among state agencies, postsecondary institutions, local education agencies, and the private sector.

Authorize a program of fellowships for existing faculty.—In order to help retain talented teachers in mathematics and science, we suggest that state boards of education be awarded special funds to provide fellowships for experienced secondary teachers of mathematics and science. The fellowships would provide for tuition, living expenses, and district substitution costs for a period of up to one semester of residence in a program which would upgrade teaching skills in the fellow's field. Upon successful completion of coursework, fellows would be awarded a bonus of up to $2,000 to be used for the purchase of necessary equipment and/or instructional materials to upgrade instruction in the fellow's classroom.

Provide incentives for LEAs to give teachers longer contracts.—One approach to upgrading the skills of teachers, and providing greater compensation without a differential salary scale, would be to authorize LEAs to use funds under this Act to give selected teachers 11-month contracts. The months when classes were not in session would be devoted to curriculum improvements, inservice, and other professional growth experiences. Similarly, provision could be made for coordinated activities with private industries interested in employing teachers for the summer months, as Sen. Glenn and Rep. McCurdy have suggested.

Focus inservice teacher development on equity issues.—The Act should explicitly encourage the use of funds for special teacher training and retraining efforts directed at overcoming sex and role stereotypes which impede the progress of women and minorities in scientific and technological fields.

Change the requirements for the congressional scholarships.—As written, we believe the Congressional scholarships may not provide an adequate incentive to talented young people wishing to enter the education profession. In addition, it would be extremely helpful to expand the scope of the program. We suggest two modifications: first, allow recipients to teach for a much shorter period of time to "repay" the assistance provided—three years would be appropriate. Second, a "performance incentive" could be developed for this program, as well. Each member of the House and Senate could be allowed to nominate more candidates if businesses and industries located in their districts or states were to donate half of the scholarship costs.

Issue Four: The bill should provide adequate mechanisms for accountability from all fund recipients. The Council believes that the bill, as written, does not provide for either fiscal or program accountability to the extent necessary to demonstrate the effectiveness of programs funded under the Act. Having experienced for several years the tender mercies of the auditors from the Education Department, who frequently appear to establish standards where none have been announced, we believe that the bill should include reasonable fiscal accountability standards. In addition, the bill would be strengthened by adoption of these recommendations:

States should be given the responsibility and authority for assuring program quality.—Clearly, it is impractical to ask the nation's 16,000 local school systems to deal directly with the federal Education Department. At the same time, education programs within states must meet state and local educational and performance standards. Therefore, the Council suggests that the bill be amended to give states the clear responsibility and authority for program accountability. Such amendments could include requirements for local plans to be reviewed at the state level, state-level evaluations of state and local program efforts, and other steps.

Accountability standards should take the form of performance standards and incentives.—The Council suggests that one way to assure adequate, agreed-upon accountability standards for programs would be to build into the Act specific areas in which states would be required to develop performance standards. As a first step, we would include the three major problems already identified: teacher supply and quality, equity, and coordination among responsible institutions.

Issue Five: The proposed level of authorizations contained in the bill is inadequate to address the problems we face. The Council recognizes the budget constraints faced by the Congress. Yet, the funding levels proposed in both Parts A & B of this bill are inadequate to deal substantively on a nationwide basis with any of even the most basic problems we have identified. The only suggestion we can offer is that you seriously consider increasing the authorization levels contained in the bill significantly. Even with a modest increase in funding, we must target funds more carefully on both who is to be served and what aspects of the problem are to be addressed. As I mentioned earlier, the Council believes that, in the long run, federal support in this area must be of the same order of magnitude as that provided for ECIA Ch. 1. In addition, I urge you to find some way to assure predictable and continuous funding. Continuity of funding is vital if state and local agencies are to integrate programs funded under any federal Act with their own ongoing programs. Additionally, while we face a national emergency today, we will continue to face a severe national problem for the foreseeable future—we will always need support for the upgrading of teachers, incentives for coordination among various responsible institutions and levels of government, and ways to address the problems posed by equity and excellence considerations.

V. CONCLUSION

Members of the Council of Chief State School Officers commend you, Mr. Chairman, and the members of this committee for beginning to address the very real problems we face in attempting to preserve national security and economic strength through educational improvements. We believe that the bill before you, HR 30, could be significantly strengthened in its promise to have a measureable impact through adoption of some or all of the alternatives we have presented with respect to the major issues raised by the bill. We hope, therefore, that you will adopt our suggestions. Members of the Council support your efforts, and we are ready to work with you and with other organizations to assure that this major national issue is addressed effectively and thoughtfully. Thank you.

Council of Chief State School Officers' Policy Statement Need For a New "National Defense Education Act"

I. INTRODUCTION

A recent Presidentially-commissioned study concludes by stating: "Today the problems of science and engineering education are more subtle than they were two decades ago. Present concerns go beyond whether we now have enough engineers and scientists and are likely to have enough in the near term future. These concerns include the ability of the scientific and engineering work force to perform effectively, the amount and quality of education in science, mathematics, and technology being provided to those who will never become scientists and engineers and the ability of the many components of our educational system to maintain and improve the quality of scientific and technical education at all levels and for a broad spectrum of students in the face of economic pressures, obsolete and inadequate facilities, reduced enrollments in many fields, and severe faculty shortages in others".[1]

II. PROPOSITIONS

1. *There is a federal role in support of improved instruction in mathematics and science.*—During the 1980s, and beyond, the challenges facing our nation will be greater than ever. The United States will experience an accelerating trend away from being a nation of blue-collar industrial workers toward a focus on high technology industries. At the same time, as a nation we need to build up our national security and revitalize our industries. Education must play a major role in meeting these challenges. Our future security and physical and economic well-being will depend on how well America faces the challenge of investing in the education of tomorrow's citizens.

Improvements in mathematics, science, and foreign language education are vital to America's future economic situation and productivity level for a number of reasons: first, sophisticated training is necessary to adequately prepare our growing work force in technological areas; second, the general level of scientific and technical literacy must be increased so that all citizens have a basic understanding of these areas in order to participate in national debate and discussion; third, as we evolve an economy based on technology and information processing, we must be able to equip the general population with the intellectual tools necessary to function in such an economy.

Our concern for trained citizens does not apply just to the general public. The U.S. armed forces are scheduled to receive significantly increased appropriations for sophisticated military equipment over the next five years. The trained personnel necessary to operate the new equipment may be in critically short supply.

2. *The elements of any federal legislation should include: incentives for persons to become mathematics, science and foreign language teachers, funds for the inservice development of teachers, funds for equipment, support for youth activities (e.g. science clubs), support for improved foreign language instruction, and support for other activities.*—A smaller proportion of students are studying mathematics and science than in earlier years. A 1980 survey prepared by the National Center for Education Statistics, sampled high school graduates across the nation. It revealed that only one-third of those sampled had taken three or more years of mathematics. Even though more than one-half of the students in academic programs had taken at least three years of mathematics, only one-fifth of the general and vocational students graduated with three years of mathematics. In science, the study revealed that only 41 percent of the academic students completed three or more years of science courses, and only 13 percent of general students and nine percent of vocational students took that same number of science courses. Since the late 1960s the average achievement scores in science and mathematics have steadily dropped.

Among American students, weaknesses in mathematics and science are especially evident in mathematical processes and higher order skills such as analyzing, reasoning, problem-solving, and estimating. Currently, 50 percent of job opportunities require these higher order skills because of the highly technical nature of the job. Japanese students spend four times as much time studying these higher order skills as do U.S. students.

At the same time, there is a growing shortage of mathematics and science teachers, particularly on the secondary level. The private sector has siphoned off many secondary and postsecondary instructors. The widening gap between academic and non-academic salaries has caused problems in acquiring and retaining high quality faculty in engineering schools and in university departments that train computer professionals, as well as at the elementary and secondary levels.

Recent NSF figures indicate that, nationwide, 16 percent of all elementary school teachers were not sufficiently prepared to provide basic training in science and mathematics. From the late 1960s to 1976, graduate enrollments in the sciences declined from 37 percent to 23 percent of total graduate enrollments. In the past 10 years, the number of secondary level mathematics teachers being prepared in teacher education programs has declined by more than 75 percent; that of secondary level science teachers 65 percent. Almost five times more science and mathematics teachers left teaching in 1980 for employment in non-teaching jobs than left due to retirement. In 1981, nearly half of the teachers newly employed to teach science and mathematics were unqualified to teach those subjects. The qualified instructors who do exist must contend with equipment and curricula that are woefully outdated.

---

[1] National Science Foundation and U.S. Department of Education "Science and Engineering Education for the 1980s and Beyond." 1980.

To further compound the problem, the Federal Governemnt's commitment to research and development in science education began declining in the late 1960s. Support for graduate fellowships in science and mathematics fell off sharply, and support for teacher training institutes and curriculum development dropped off dramatically in the 1970s, before virtually disappearing. University science and mathematics departments have not moved to be responsible for the training of new science or math teachers.

Recommendations to implement proposition number two include:

1. *Support for Teacher Preservice and Inservice Training,* to address ways of coping with the shortage and quality of teachers in mathematics, science and foreign languages;

2. *Support for Equipment and Instructional Materials,* to enhance student learning in mathematics and science; and

3. *Support for Other Incentives,* such as the creation of support groups and private sector involvement.

In the area of teaching staff, two problems must be addressed: (1) how to keep teachers current with the latest scientific and technological developments, and (2) how to make school systems more competitive with business and industry in attracting persons to teach initially. A "summer institute" program should be implemented. Such institutes would improve teaching qualifications through exposure to new teaching methods, instructional materials, developments and applications in the field, career opportunities for students, and on-going research. Keeping schools competitive with regard to attracting persons to teach science and mathematics, particularly at the secondary level, is a complex problem. Examination must be made into the feasibility of providing incentives to students to teach rather than join industry—perhaps by loan and fellowship programs.

The fields of mathematics and science are particularly vulnerable to the rapid obsolescence of instructional material. Allowable expenditures under any Federal program should include assistance to school districts to maintain reasonably up-to-date texts and library resources. School districts and States could use funding to meet their needs, including at least: new science and math sequences which match the stages of children's intellectual development; updated curricula which accommodate technological and social changes; and new mathematics and sicence equipment, including computer hardware and software.

Other incentives which could significantly enhance mathematics and science instruction if emphasized at the Federal level (and State and local levels, as well) include, at least: the development of a strong network of student organizations such as authorized under P.L. 85-875, "Clubs for Girls and Boys Interested in Science;" tax incentives for businesses which contribute equipment and training in its use to schools; and incentives for cooperative ventures with science museums and private business labs.

3. *Support for foreign language instruction is part of the Federal role in support of education.*—Statistics clearly reflect the dramatic drop in foreign language and cultural instruction at the elementary levels. In 1966, 34 percent of colleges required entering students to have a background in a foreign langauge; today, only eight percent do. Of the total enrollment of foreign language studies students, less than one percent study those languages—Chinese, Japanese, Arabic and Russian—which comprise the spoken lanuages of 80 percent of the world population.

Broad scale language proficiency, like science and mathematics education, is critical to the nation's future for at least these reasons: Trade and economic development in a global economy depend on our ability to communicate with trading partners; and national security requires that we be able to understant the major world cultures and political groups, a task which cannot be accomplished satisfactorily without widespread language proficiency.

The American public's decline in Foreign language proficiency has not gone unnoticed. In November of 1979, the President's Commission on Foreign Languages and International Studies set its agenda for greater emphasis on precollegiate international education in its report entitled "Strength Through Wisdom: A Critique of U.S. Capability." In addition, Congress is also aware of the problem. Legislation entitled the "National Security and Economic Growth Through Foreign Language Improvement Act" (H.R. 3231) was reported out of the House Education and Labor Committee in October, 1981.

The bill provides for competitive grants among the states for funding of model foreign language programs run by local school districts. At the postsecondary level, the bill provides grants to institutions based on enrollments for assistance in paying the costs associated with foreign language instruction at the institution.

Recommendations to implement proposition number three include:

1. Comprehensive legislation should be introduced, focusing on assistance for: (a) state agency direction and coordination of international and foreign language programs; (b) agencies to provide professional development for teachers, coordinators, department heads, and administrators in schools; (c) experimental interdisciplinary programs, particularly between social studies and foreign languages; (d) rural, poor or small schools and districts, as well as schools in urban areas; (e) instruction in the less commonly taught (but most commonly spoken) of the world's languages; (f) technical support to teachers interested in teaching Chinese, Japanese, Russian, or Arabic; (g) status surveys and information gathering on foreign language and international education; and (h) promoting international exchanges of persons in the performing arts and exhibit displays.

2. H.R. 3231, the National Security and Economic Growth Through Foreign Language Improvement Act, or similar legislation, should be enacted as soon as possible and funded at an appropriately high level.

3. *Federal support for math/science/technology education should be administered through States and should be of sufficient scope to have a significant impact on the nation's schools; we expect significant State-level developments in this area as well.*—It is important to provide flexibility for state and local education agencies to be able to use funds in the areas of their own greatest needs. Recent surveys show, for example, that science teacher shortages vary by field and geographic areas. Similarly, the exposure of high school students to science and mathematics varies by state. In New York State, for example, 57 percent of high school students following an academic track take three or more years of science, while only 41 percent of such students nationally take three or more years of science.

State and localities are facing their specific needs in these areas as their resources permit. Kentucky, for example, has initiated a student loan forgiveness program for future science and mathematics teachers. Other states have initiated curriculum reforms, regional cooperatives for sharing materials including computer software, and taken other steps to address their own needs. National legislation, therefore, must allow states and local education agencies the flexibility to address their own needs.

4. *The federal role in the areas of math/science/foreign language/technology education is linked to the federal role in support of "human capital development" generally, as well as to defense preparedness through personnel preparation; training for high technology occupations, math and science education, and defense preparedness are interrelated activities; public school vocational-technical education programs can contribute directly to the needed manpower of the military services through specific training programs keyed to Military Occupational Specialty (MOS) needs; both the private sector and the defense establishment can contribute to and benefit from national policies in these areas.*—Presently, there is strong competition between the military and private sectors for a shrinking pool of skilled human resources. As innovators in complex weaponry and other technologically sophisticated systems, the armed forces are a likely source of new high technologies which eventually benefit private businesses and industries. The number of young people is shrinking, while the needs of the nation for a better qualified technical workforce are well documented. Some human capital development to realign the available skilled human resources to new labor market realities will depend on retraining of the existing workforce. Much, however, will also depend on the types of training received by young people entering the workforce.

Historically a vital part of the nation's defense, education plays an essential role in today's armed forces as military management and individual duties of service members become increasingly complex. High quality educational opportunities not only ensure high quality troop performance, but become both a primary recruiting attraction and a means toward inservice and post-discharge career advancement. The military services' need for qualified personnel, the desire of service men and women for educational access, the changing needs of the private sector, and postsecondary institutions' interest in delivering programs of excellence form a natural base from which to explore cooperative educational ventures.

Within the areas of defense related training and development, the Council recommends that legislation be adopted in at least these areas:

1. In view of the fact that a significant percentage of America's high school graduates enter the military directly, the federal government could fund vocational training programs to prepare students to fill chronic or anticipated MOS shortages.

2. Skill shortages exist in key areas needed by the military and private sectors in both high technology and basic skills areas. In view of the competition between the

military and private industry for the same personnel, the federal government should support ways of sharing training techniques and curricula between defense-related and private sector industries, using postsecondary education institutions as cooperative links. Instructional techniques and curricula developed by the military and by secondary, postsecondary and vocational education institutions should be transferred among the military, the private sector, and educational institutions.

3. The appropriations and the number of approved units for the Reserve Officers Training Corps (ROTC) program should be increased by Congress in view of growing waiting lists of institutions applying for a campus-based ROTC program, and to encourage a more equitable nationwide distribution of such programs. At the same time, the Department of Defense, together with appropriate representatives of education institutions, should establish a "Reserve Enlisted Training Corps" (RETC). This new program could address two objectives for the DOD: to ensure that enlisted personnel have necessary skills and to use the educational and training resources of educational institutions rather than requiring the DOD to create its own training facilities. The ROTC program bypasses the junior and community colleges, while junior ROTC introduces the officer training concept at the high school level; therefore, the junior and community colleges appear to be a suitable intermediate level to introduce an ROTC program.

4. A new G.I. Bill, including improved educational benefits as a military recruitment and retention incentive and as an important provision to prepare persons for new careers upon leaving the military, should be enacted.

5. Further exploration and development of cooperative research and development ventures among educational institutions, should be initiated. New federal dollars now being provided through increased funding for defense-related research and development should be used to encourage more cooperative arrangements between the civilian and military R&D communities.

6. *Both federal and state efforts to support improved instruction in math, science, technical fields and foreign languages should have a significant focus on increasing access and equity; the particular needs of women and minorities must be addressed in this national effort.*—Historically, women and minorities have been underrepresented in these fields. For example, a 1980 estimate by the National Center for Education Statistics places the proportion of females taking three or more years of mathematics in high school at only 26 percent, far lower than the percentage of males. For minorities, the situation is similar: 82 percent of white high-school students take first-year algebra, but only 68 percent of hispanics. Sixty percent of white students take geometry, but only 39 percent of black students do so. Women and minorities together make up 60 percent of the population but a mere five to ten percent of the nation's engineers. We must find ways to take advantage of this resource.

In urban areas, there are generally inadequate vocational and technical training opportunities available. The Council recommends that national legislation addressing science, mathematics, and technical education should at least:

1. Incorporate as a specific goal the provision of increased opportunities for women and minorities to participate in educational programs.

2. Provide for special teacher training and retraining efforts directed at overcoming sex and role stereotypes which impede the progress of women and minorities in these fields.

7. *Federal legislation to support mathematics, science, foreign language, and technical instruction must incorporate and assure an adequate level of financial support.*—Previous federal efforts in the mathematics and science areas have been funded at fairly modest levels. Even the first incarnation of the National Defense Education Act was only modestly funded. The Council believes that federal education programs which in the past have been accused of "failure" have often simply been inadequately funded. A successful federal program, ECIA Chapter I, is funded at a level which provides about $450 support for each child served. Yet, it is a targeted program which only serves about half of those eligible, and the eligible population is relatively small. We believe the level of Federal effort in support of mathematics, science, foreign language and technological instruction should be at least on the same order of magnitude as ECIA Chapter I.

The point, therefore, is that for any significant positive efforts to be realized, funding must be at the level of billions rather than millions. In addition, a program must have continuity of funding over a period of several years in order to be integrated into local and state efforts.

Chairman PERKINS. Thank you very much, Mr. Raynolds.

Now Mr. Thomson, I notice you observed the testimony of the council of chief state school officers. All of us would like to see this money go into every school district in the country.

You know, here we have got a terrific shortage of funds. If we had adequate funds, we won't have any problem at all. But Mr. Raynolds raises the question that we should leave it up to the chief state school officers. My only worry is where we have so many poorer school districts that will not share at all, and if we had adequate funds, it would be a horse of a different color altogether.

I would like for you to address that problem. Go ahead, Mr. Thomson.

Of course, we are not in concrete by any means. We want to do the best thing here.

Mr. **Raynolds**. Mr. Chairman, do you mean me or Mr. Thomson?

Chairman **Perkins**. Mr. Thomson.

STATEMENT OF SCOTT D. THOMSON, EXECUTIVE DIRECTOR, NATIONAL ASSOCIATION OF SECONDARY SCHOOL PRINCIPALS

Mr. **Thomson**. Mr. Chairman and members of the subcommittee, my name is Scott Thomson. I am executive director of Secondary School Principals, a group of 34,000 principals, assistant principals who serve the high schools, the junior high schools and the middle schools of the Nation.

I would like to point out that my written testimony has been distributed and I will not comment in great detail on it. I would, however, like to summarize six main points, including the point, Mr. Chairman, that you raised as you introduced me to the podium.

First I would like to say that the entire problem that the subcommittee has been considering and discussing today was brought home—literally home yesterday in Reston, Va., across the Potomac where I live, when we learned that the chairman of the local middle school, Langston-Hughes Middle School, had resigned effective today at the beginning of the second semester, and Adrian Moore has gone to work for a high tech company in the data processing field.

So we sit here today and find a 1,000 students at that school without a department chairman in math and with a substitute teacher in the classroom. I think that is a capsule of the story that we have to face right here, and multiply that by 500 or 1,000 and we do see the problem.

The subcommittee will have the opportunity to sift through a number of promises over the coming days and weeks, and I know that you will use your very best judgment as you pull together a composite bill that will address this very serious problem, but I would urge that the committee look for six essentials as you prepare the legislation and shape it for final passage, we hope, in the House.

And I think that these essentials are terribly important to a comprehensive attack upon this whole matter of improving signs and math education in this country as an absolute necessary step to maintaining our economic competitiveness as a nation.

I hope that you will look then at this legislation through these six lenses. One, I think it is absoultely essential—we do, the principals of the Nation—feel that it is absolutely essential that this legislation include strong incentives for becoming a math and science teacher, such as for example H.R. 835, Congressman McCurdy's bill concludes.

We believe that forgiveness loans are the best answer for providing incentives for young people inclined toward math and science education to enter the field. We are not naive enough to believe that every math and science major that accepts a loan should this legislation be passed, and goes on and teaches—and we would urge that the loan—that the loans be for the full tuition and subsistence requirement for college students—we are not so naive to believe that they will all stay in education after the 4 years are up, but we believe that you need a larger number of math and science teachers entering the field to maintain later on a sufficient number, because some of those math and science majors who perhaps didn't think about entering teaching prior to a loan program coming along will stay in education.

So we urge you to consider a strong incentives program, not a modest one, but a strong one; one that will go a considerable distance toward making up the difference between what a beginning teacher will make and what that same person could make in the private sector if we are going to provide the equivalent of 1 year's tuition and room and board for that first year teacher along with his or her salary.

The second element we would urge you to include in any legislation in this area is to provide incentives for remaining a teacher. This is obvious. It was discussed and has been considered here today. Mr. Goodling alluded to it.

Basically it all comes down to the question: how do you keep 'em down on the farm after they have seen Hewlett-Packard, and it is a problem; a very real problem. We don't believe that you keep 'em down on the farm by paying a differential to the teachers. We believe that is a serious mistake.

The principals of the Nation have had to live for 25 to 30 years with the differential in pay to the Vocational-Education teacher. It creates a lot of difficulties. We would much prefer an arrangement for supplemental pay in the summertime, workshops with stipends to attend those workshops, recognition, and most of all better working conditions for those teachers.

The third element we would urge you to include in legislation to improve the Nation's position in math and science education and in math and science technology is the provision for modernizing and updating skills. The National Science Foundation in earlier days, Mr. Chairman, as you know, was very successful in training science and math teachers in summer institutes. The only problem was that that development came along at the exact same time as this Nation was establishing junior colleges, and far too many of those high school teachers with NSF training went on to teach in junior colleges.

I submit we do not face that same problem today.

I think the fourth element of a comprehensive substantial math science program would include some provision for new equipment. You need high tech equipment, not only in factories and industrial establishments, you need it back in the classroom as well.

I realize that earlier some of this money was wasted, and some supersalesmen pushed off some materials that perhaps should not have been purchased by schools. But I would urge that the committee, subcommittee, as it looks at this legislation, look carefully at providing for the replacement of obsolete equipment. Most of that equipment is now a generation old. I would urge you not only to provide for new equipment, but also for the replacement of equipment. We don't only need fancy new science equipment in optics or electronics; we also need in many cases better microscopes, balance scales, et cetera.

The fifth element I hope we would include would be a provision for private sector assistance, not only consultants and interns and that kind of personnel help, but also tax incentives, such as have been proposed in H.R. 836 and such as Congressman McCurdy discussed this morning.

And finally, to get to the question that you addressed to me, Mr. Chairman, we would urge that almost all of this money be provided directly to school districts. We realize that it must be administered through the States, and with all due respect to the very excellent people, chief State school officers in this country, what we do not need are more coordinators, more administrators.

We have sufficient infrastructure, much of it built by Federal funds in State departments today. Let's use that infrastructure to improve our math and science programs, and make sure that that money gets to the classroom teacher and to the student, because that is where it will make a difference. It will not make a difference if we simply spend it on coordinators and advisers and consultants. That doesn't help the student who will be the scientist or the mathematician of the future.

So in closing, let me express my appreciation for this opportunity to testify before you. And I do urge you to consider these six elements as you go about thinking and working and drafting your final legislation.

Thank you very much.

Chairman PERKINS. Thank you very much.

Of course, there is a sharp difference between you and the gentleman who testified just before you. He wanted to go direct to the school districts.

[Prepared statement of Scott Thomson follows:]

PREPARED STATEMENT OF SCOTT D. THOMSON, EXECUTIVE DIRECTOR, NATIONAL ASSOCIATION OF SECONDARY SCHOOL PRINCIPALS

My name is Scott Thomson. I am the Executive Director of the National Association of Secondary School Principals, the largest school administrator organization in the nation, representing some 34,000 school site administrators. I am pleased to testify before you today on behalf of NASSP's membership, which shares a growing concern about the declining state of mathematics and science instruction at all levels of our educational process.

Before expanding on the problems in mathematics and science, and the means of addressing those problems, I want to applaud the leadership that you, Mr. Chairman, and your distinguished Committee are demonstrating by holding this important hearing on the very first week of the 98th Congress. By moving expenditiously on this critical subject, the necessary signals are being sent to your colleagues in Congress, the Administration and the education community that action must be taken now to reverse the severe decline in mathematics and science education. You can be assured that the nation's secondary school principals will assist you in every way possible to expedite appropriate legislation in this area.

The need for action is clear. Our nation's labor market is rapidly changing as the demands of an information society become more apparent. The demand for technical mathematics and science oriented skills is skyrocketing, while the demand for labor in the smokestack industries is contracting. All sectors of our society will have to play a part in addressing the challenges of these major changes in the nation's work force, but without doubt schools will play the most central role. It is in our schools that tomorrow's work force must acquire the flexible skills that will be required in a increasingly technical job market. And it is precisely in this area of instruction that we find the greatest disrepair in our elementary, secondary and postsecondary schools.

Even today the pool of workers sufficiently equipped with the skills to perform technical work is insufficient. Industry, business and the military report that new employees and recruits often lack the competence to perform a broad range of increasingly technical responsibilities, and projections indicate no reversal in this trend. The future strength and vitality of the U.S. economy, and our traditional preeminence in high technology markets is at stake. Reversal of these ominous trends must begin now, and must be triggered by a national commitment based on investment in our human capital.

The State of Mathematics and Science Education in Elementary and Secondary Schools.—Today elementary and secondary mathematics and science instruction is in disrepair. Recent surveys indicate that at the secondary level 43 states have a shortage of mathematics teachers, 42 states report a shortage of physics teachers, and 37 states report a shortage of chemistry teachers. These shortages are rapidly worsening as the rate at which teachers left our schools in 1980–81 amounted to four percent per year. The exodus of experienced teachers is compounded by the lack of new teachers joining the profession. Between 1971 and 1980 only one-half of all secondary mathematics and science student teachers entered the teaching profession. This trend of fewer mathematics and science college graduates entering teaching was also found in a survey done by the National Science Teachers Association indicating that in the past decade we have experienced a 77 percent decline in the number of secondary-level mathematics teachers prepared.

Because of the dwindling number of experienced teachers, and the insufficient supply of incoming graduates into teaching, school principals have been forced to place unqualified or underqualified teachers in many of their mathematics and science classrooms. The end result, of course, is self-evident, students are instructionally under-served, and parent and community confidence in schools is compromised. Ultimately, students will not be as well prepared for pursuing technical jobs or a mathematics or science major in college. The latter is well documented in a 1980 study of probable majors of entering freshmen in higher education. The study indicated that in 1970, 52,400 college and university freshmen planned to major in mathematics or statistics. The number declined in 1980 to 10,250. This amounts to an 80 percent decline in the number of college freshmen planning to major in mathematics.

Another telling statistic is the declining number of graduates with earned bachelors degrees in mathematics and science.

NUMBER OF EARNED BACHELORS DEGREES IN MATHEMATICS AND SCIENCE

	Mathematics	Chemistry	Physics	Biology
1970	27,442	11,519	5,320	35,743
1980	11,378	11,232	3,396	46,370

As you can see in the above chart there has been a 41 percent decline in the number of graduates holding mathematics degrees and a 63 percent decline in the number of physics graduates, while chemistry degrees held steady, and biology experienced a significant increase.

These statistics place in perspective our long-range problem, the need to stimulate more interest in mathematics and science amongst our high school students, and to provide incentives to pursue degrees in these technical subjects.

RECOMMENDATION I

We urge that H.R. 30 address the shortage of mathematics and science teachers in our schools by providing loans to college mathematics and science majors with a forgiveness provision that cancels 25 percent of the loan for each year of teaching in an elementary or secondary school.

Twenty-five percent per year is clearly more costly than the ten percent allowed in the NDSL program, but the rationale is clear. Mathematics and science graduates are foregoing the teaching profession because starting teacher wages are dismally below comparable entry level jobs in industry which require essentially the same skills. If a new graduate can pay off one-fourth of his or her entire college loan (amounting to perhaps $10,000) for each year of teaching, then the $14,500 first year teaching salary coupled with the $2500 forgiven loan essentially places him in the $16,500 income bracket. This makes the teaching profession's salary more competitive with industry. Of course, if the graduate elects not to teach the loan would come due much the same as other federal student loans.

The State of Student Achievement in Mathematics and Science.—While this past decade has seen a decline in the quantity of teachers in mathematics and science, our schools have also seen a decline in the quality of that instruction as evidenced by waning student achievement in mathematics and science.

We have seen a steady decline in SAT mathematics scores over the 18-year period through 1980, amd similar declines in student achievement scores of 17-year olds in three national assessments, 1969, 1973 and 1977. The need for strengthening skills of our present cadre of teachers while increasing high school graduation requirements in mathematics and science is almost universally accepted. Only one-half of all high school graduates take a mathematics or science course beyond the 10th grade, and the average number of years that college-bound students take mathematics is 3.52 years. College-bound students take an average of 1.79 years in the physical sciences.

Our schools must begin to motivate students to become more literate in these areas. In the long term, the negative effect of a continued decline in the understanding of mathematics and science will result in the nation's not meeting the needs of our armed forces, our industrial and high technology enterprises, and generally the understanding of the role mathematics and science play in our ever increasing technical quality. Our teachers must be given the opportunity to upgrade their subject and teaching methods skills to reverse this declining student achievement trend.

RECOMMENDATION II

We urge the Committee to include as a major component of H.R. 30 a program of in-service training to enable all of our present mathematics and science teachers to upgrade their teaching skills.

Language to authorize such a program must be carefully drafted to assure that school officials will be given the flexibility to design a plan best suited to serve their unique needs. The principal focus of such a program must be locally based so that the goals and objectives of local administrators, not state or federal bureaucrats, will be carried out. Local administrators must be able to establish cooperative programs with local colleges and universities, and explore greater cooperation with local business and industry officials to achieve their goal of upgrading their mathematics and science teacher skills and experiences.

Schools Must Re-Tool Their Classrooms and Laboratories.—Our efforts to thoroughly strengthen our mathematics and science instruction would be incomplete without a significant investment in curriculum materials and laboratory equipment. If secondary schools are to expand their services particularly in chemistry and physics, resources must be available to purchase the tools necessary to provide an exemplary science and mathematics learning experience to our students. Since the NDEA there has been a general deterioration of these materials in our secondary school class rooms. A study done in 1977 found that only 45 percent of all secondary schools possessed some kind of science equipment, and those schools that did had budgeted an average of only $5.50 per student. This is clearly an insufficient number of schools with laboratory equipment to enabel our physics and chemistry teachers to provide an enriching learning experience to their students.

RECOMMENDATION III

We recommend that H.R. 30 include a provision that enables administrators to purchase needed equipment, materials and supplies for mathematics and science laboratories and class rooms. In these times of very limited resources we recognize a need for restraints in this area, but a rekindling of mathematics and science instruction must be accompanied by investments in laboratory equipment.

New Incentives for Business to Cooperate with Schools.—As I testified last September, Mr. Chairman, greater cooperation between schools and business and industry must be pursued if we are to strengthen our mathematics and science instruction and keep up with the rapidly changing technological advancements and applications of knowledge. While I understand that this Committee has no jurisdiction over the tax code, I feel strongly that this Committee's recognition and backing of a concept of providing tax incentives to businesses which assist schools will be most helpful in subsequent Ways and Means Committee deliberations.

RECOMMENDATION IV

We believe that industry and business must be encouraged to assist schools in stopping the exodus of our most talented mathematics and science teachers. The Glenn/McCurdy tax incentive bill is designed to stop this talent drain that schools have been experiencing, by addressing the tremendous differential that exists between the classroom and industrial work place wages.

The bill would provide tax breaks to businesses which hire mathematics and science teachers over the summer months in high technology jobs. In this way, two of the primary causes of disrepair in mathematics and science instruction could be alleviated. (1) mathematics and science teacher salaries would be supplemented, thus removing some or all of the financial incentives to leave the class room for more financially lucrative industry jobs. And (2) teachers would be given the opportunity to learn the latest applied uses of technology in such diverse industries as computers, petro-chemicals, electronics, and agricultural technology, to name a few. Teachers would bring these rich experiences back to the class room, thus strengthening their student experiences while knowing that school and industry officials have a greater recognition of the vital role they play in the classroom.

Furthermore, we urge support of legislation providing tax incentives to industry to share their employees who hold teaching certificates with the schools on a part-time basis. This would require little or no bureaucracy, just some negotiation between school districts and their local industries. The benefits would be great. Aside from filling a Chemistry II or a physics or calculus class with a qualified experienced instructor for perhaps ten hours a week, we envision schools taking advantage of this increased cooperation with industry in a number of ways. The cumulative interaction between school administrators and industry officials would be unleashed to the benefit of the students.

In conclusion, Mr. Chairman, the solutions to reversing the decline in mathematics and science instruction and the national challenge of addressing the world's increasing technological demands are many. No one institution, nor level of govenment can do it alone. Be assured that the nation's school principals will assist you in every way to give schools the resources necessary to play their vital roles.

I thank the Subcommittee for the opportunity to share our views about how our schools can contribute to solving this national crisis, and pledge our assistance to both of these distinguished Committees as you move to fashion a politically and economically feasible solution. Thank you.

I would be pleased to answer any of your questions.

Chairman **Perkins**. We will now hear from Brookings Institution, Professor Roy.

STATEMENT OF RUSTUM ROY, BROOKINGS INSTITUTION

Mr. **Roy**. Mr. Chairman and members of the Education and Labor Committee, and other Members of Congress, I think not only is the committee to be commended, but perhaps to be warned, because I am sure many of you realize that the size of the problem you are addressing and its importance should be commensurate with the bucks you are going to put behind it. Because in a pamphlet I have written I call "The Technological Rearmament of America," this Nation's defense will be better served, I believe, and I adduce evidence for, by helping industrially trained, technologically literate citizenry, than by one more weapons system.

So I hope some of you will not lack the courage to see that the importance of this problem is so great that it really needs a much healthier and sustained economic base.

Mr. Chairman, I come out of a community that is not highly represented in your committee hearings usually, the research scientist community. I direct a lab in which I get $4 million a year out of NSF and other agencies. I am afraid to report that our community has not had a distinguished report with respect to helping science education at the elementary and secondary level. We have much to be blamed for. We have felt that somehow we would erect on a plane of illiterate citizenry a flagpole of an elitist group of scientists. That model is simply not tenable any more.

What we need is what the other nations have done, to erect a pyramid where everybody has some technological awareness, and slowly build that up so that Mr. Goodling's PTA and the school board is also concerned, concerned enough that they will support science teachers. So we need to have that kind of pyramid base instead of our flagpole base.

Mr. Chairman, I want to make only three points from my testimony, and I will pull them out because they are rather different from what my colleagues have been saying previously.

My first point is, what is the target audience of the new incentive?

I submit there is a new target audience, and that it is different from the one that we went after in the National Defense Education Act to which you have referred. It was a strategic error I believe in what we did in 1958. We went after making more scientists and engineers and making damned good ones.

Professor Conant, when he retired as president of Harvard, said we don't need to worry about those guys, they are so good that they will take education away from even bad teachers; what we need to be concerned about is the rest of the population. So I believe that 1 percent of the population, the science and engineering community, that is us, we don't need the money. The people that your bill should address are the 99 percent; we will float on top of them. If the 99 percent of the population is technologically literate, we don't need to worry about the 1 percent.

Now, I think that that is a very important distinction from NSF's approach, which is trying to make better scientists and engineers. Let them worry about that. Somebody has to worry about how you make a technogically literate population. I suggest this is the right committee to do that.

My second point is, what are we going to do that is different. Are we just going to repeat the mistakes of NDEA, or is the content going to be exactly the same, one more course in math and one in physics. It is not going to cut the mustard. There is something new in the field of education.

Let me propose to you this is the safeguard you wanted. I believe that unless we motivate students, content will not cut the mustard any more. Just content is not enough. Motivation on science and technology is the key. It is something we have never done before. How do we motivate young girls and boys to get interested in it?

There has been in the last decade a radical change in our understanding in the universities, on a thousand campuses across the country, a new subject matter field has come into the business. It is called science, technology, and society. It linkages, in Mr. Kissiger's terms, technological activity with our societal needs. Unless a local school board chairman sees that the pollution or the business is connected with the math and science education, he is not going to support it. So I believe what we have to do is press that linkage—science, technology, and society, abbreviated STS. That is a new subject matter on our campuses in the universities. It is slowly coming into high school.

Let me show you this is not an idiosyncratic idea of mine. Mr. F. James Rutherford, former Assistant Secretary of Education in the last administration, has said precisely the same thing to all the liberal arts colleges. The most important base that would verify this is the National Science Teachers Association. They issued a few months ago a position statement on what they think should be done. And their proposal is that 20 percent of all the science education should be in STS at the high school level, 15 percent a little lower, 5 percent at the elementary level.

Who is going to make the textbooks, where is the material, if that is true? And that is the consensus of a lot of teachers, not only us academics and research scientists. In Britain—I have had sent to members of other committees in the Congress—they have a whole set of textbooks, of teaching science and technology through science, technology, and society. I believe that is the motivational key which unlocks a continuing interest in the subject matter.

My third point addresses your cost-effective related matter, how do you make sure you get enough bang for the buck with these new sexy technologies?

In your section 625, you ask for research on some of these new technologies. I believe that is very important, Mr. Chairman. You will avoid all the hype of the salesmen. Otherwise, we are going to have all those dogs, all those secondary models which they palm off on school districts. And the worst and most difficult thing is to know which technology is going to be beneficial to education. We are not clear that finger-math from Korea is inferior to a calculator from Hewlitt-Packard. So you must continue research on finding which technologies are really effective and which are just to be brought in because industry wants to sell it to us.

On the research equipment section, Mr. Chairman, in 625 I believe you have an absolute secret weapon in section b(3). I would urge you avoid the rest of it in providing equipment for universities I am now talking about. But in section b(3) you have done something which is unique, which is to provide a means for the sharing of equipment, provide incentive for sharing.

The most cost-effective technology today is sharing. Every professor wants his own batch of equipment right around him. Let's make sure that the incentive is there for the sharing of equipment.

Last but not least is your institutional problem you have been addressing, Mr. Chairman, how do we go about this, the Department of Education, NSF, and so on.

With respect to the single point of academic involvement, university involvement, may I suggest that Congressman Brown on the National Technology Foundation not be ignored. It is a potential move which would integrate the technological base of the country with technological literacy, with the kind of training that we need, the technical technician education, into a single agency. I believe we may need a new agency to bring some of these things together.

Thank you, Mr. Chairman.

Chairman **Perkins**. Thank you for a good statement. We are having a lot of diversity of views here today, which is very interesting, at this hearing.

[Prepared statement of Rustum Roy follows:]

Prepared Statement of Prof. Rustum Roy, Science and Public Policy Fellow, The Brookings Institution

Mr. Chairman, your bill H.R. 30 tackles perhaps the most significant problem facing American education today: the appropriate incorporation of additional mathematics, science and especially technology into every level of our educational system.

I speak from the vantage point of an active research scientist and director of a substantial research laboratory, but one which has been actively involved with science and technology education from the level of the American public-at-large to graduate students in applied physical sciences. And I start with an acute awareness of the absolute requirement of cost-effectiveness in all the programs to be supported under this bill, if $300 million dollars is to make any meaningful impact on the problem. I will divide my remarks into three portions. First, what is the most important target audience? Second, what is the novel content of the teaching or is it just more of the same? Third, what are likely to be cost-effective aspects of the technologies (including advanced instrumentation) for education?

1. THE TARGET AUDIENCE

Approximately 1 percent of the population of the U.S. have been trained as engineers or scientists. I believe that science education in the U.S., partly under the misguided influence of the academic research scientist community, has attempted to erect as it were a flagpole of high scientific/engineering competence which is a tiny 1 percent minority, built on a sand plain of a 97 percent technologically illiterate populace. Most other countries have opted for a more stable pyramid; with large numbers having a modest acquaintance, and gradually decreasing numbers getting correspondingly increasing competence in technological understanding.

After Sputnik, under the National Defense Education Act, we embarked on a process to make an even better breed out of the 1 percent engineer-scientist cohort group. We failed. The reason for this is that as President Conant of Harvard observed decades ago, we do not need to do much for the highly motivated, brightest students. By the time they finished college they have extracted even from the worst among us teachers the stuff they need.

American math and science education is grossly deficient not in the training of engineers and scientists but in not training of those who will pay the bill for benefit from, or suffer the ill effects from, the work of this technical community.

I would therefore especially support those sections of the bill which tend in this direction as against those that seek to increase the numbers of scientists and engineers. Thus I believe that Congressional fellowships would serve the nation best if they sought out those exceptional students which, principally for financial, sex (or other) disadvantage, would be lost to the personnel pool. The others, especially at the postgraduate level, have ample, indeed better, sources of support in the sciences and engineering.

I conclude therefore that the national interest will be best served by this bill if explicit mention is made wherever appropriate that the target audience should be the general citizenry who will not become professional engineers or scientists.

2. NOVEL CONTENT OF THE MATH-SCIENCE-TECHNOLOGY (MST) TO BE IMPARTED

It can easily be shown that the total expenditures in pre-college and college MST education are so large that unless the $200–$300 million in this bill were very carefully placed it would exert virtually no leverage on it. Moreover, it can be argued that the "technological illiteracy" of the American people has been caused by the present system offering a certain content in a certain way, so how can its expansion help the problem? Clearly some combination of form and content in our MST teaching turns off the vast majority of our students from the exciting venture of understanding and even changing our world.

Over the last decade on a thousand college campuses across the U.S. completely unplanned and unorchestrated, I believe, a most significant answer has emerged to the question: What will it take to interest and hold the interest of the average

American primary and secondary school student in MST? The answer is unequivocally: The subject matter which today focuses on the field of Science and Technology and Society (STS). Let me explain the reasoning behind this claim. It begins by determining the optimum content of general education for school as well as college students in the late 20th century. Educators from all over the world whether in Poland, in Britain, or in India recognize that to be an effectively functioning citizen in the world of today requires an awareness and rudimentary understanding of particular aspects of applied "MST".

If interest in such subject matter is to be maintained throughout school and college, then that MST subject which is a felt need of the "citizen" must be the connecting link. STS as it is now universally called starts with the citizen in her/his society. What does she or he need to know to function well, manage life and social community affairs, vote intelligsently, etc? The linkage should always be made in the following sequence: individual-society-technology-engineering and last of all the abstract principles of science. This is virtually the reverse of what we often attempt in our schools. Our new slogan is: "Technology-related-to-life" is "technology-remembered-for-life": This is what made the American farmer the most technologically balanced citizen in the world. The goal of STS teaching of and about S&T is a 21st century version of that kind of understanding.

I have written recently (see enclosures) that STS is the absolutely required core of technological literacy. But this is no invention or idiosyncracy of mine. Professor S. Goldman, Mellon Professor of the Humanities at Lehigh University (Bull. Sci. Tech. Society, 2) has described the symbiotic relationship between STS and technology literacy. Dr. F. James Rutherford, former Assistant Director of the National Science Foundation and Former Assistant Secretary of the Department of Education, writing in "Forum", the journal of the small libreral arts colleges, says: "The lesson of Sputnik is its failure to catalyze a broad guaged and lasting reform movement in science and technology education. Every student needs a good general education and in these times such an education must pay substantial attention to science and mathematics and their applications." The Editors of the same journal, in the editorial in the same issue, write: "In a world with increasing technological and scientific complexity, science literacy must be more than the understanding of a few basic principles in the biological or physical sciences. Rather, it must encompass the ability to apply an understanding of science principles, methodology, capabilities, and limitations to the wide range of decisions students will face both as citizens and as professionals."

Perhaps the most telling witness comes from the official position statement of the National Science Teachers Association which is even titled: "Science-Technology-Society: Science Education in the 1980's." While some other material may be called STS-related this NSTA position statement calls explicitly for increasing amounts of: 5 percent STS material at the elementary level, through 15 percent at the junior high level, to a "minimum of 20 percent of science instruction should be directed toward science-related societal issues." (Emphasis added throughout).

The significance of this kind of statement should not be lost. Remember that we have 100 years of tradition, millions of textbooks, tens of thousands of trained teachers in math, physics, chemistry, biology. Yet what many experienced individuals and representative groups are calling for is at least 20 percent of the instruction (say equal to all that in chemistry) to be given in a new field, STS. Moreover, it is our claim that this is the kind of subject matter which will help most directly in stimulating and maintaining the interest of the vast majority of our citizens in S&T affairs. Clearly if STS is this important, as many of us believe it to be, it will need to be singled out for attention. It is, in my opinion, the newly found key to cost-effective improvement of the technology literacy of the country.

It is particularly important that especial attention should be paid in the bill to the training of teachers and the preparation of teaching materials at all levels in this subject matter field. At the high school level the British are far ahead of us, and some excellent material has been prepared. This material introduces the technology and science through the students' interest in food, or sewage treatment, or robotics, with an even-handed treatment of the potential good and harm that can result.

3. COST-EFFECTIVE EDUCATION-RELATED TECHNOLOGIES

In Section 624 the Bill treats the question of educational research and mentions the efficacy of the use of new instructional technologies. However, while the sex appeal of some of the new information technologies (e.g. the computer software) gets them attention, the real action may be elsewhere. The on-site reproduction and the use of modular text material has radically altered the science and engineering textbook business in colleges. It will soon affect high schools. In pedagogical optimization strategies, the cost-effective preparation and dissemination of the teaching materials in short modular units in print (still the most used), video and computer formats has been badly neglected. It is the simplest strategy to be able to continuously update material and, indeed, continuously improve and keep the content relevant to industry's needs. The N.I.E. could provide a long-term national fund for matching support of the production of teaching materials in mathematics, science and engineering by national consortia, based in universities but involving industry and government personnel.

The research alluded to in this section should explicitly address the matter of both positive and the potential negative aspects of the impact of computer usage on reasoning ability such as those hinted by Kenneth Olsen, President of the Digital Equipment Corporation in his NAE Founders Award lecture (November 1982). It should compare, for example, the costs and educational benefits of Korean figermath as compared to calculator usage. It is far from certain that early introduction to such instruments is good for reasoning or logic or mathematical abilities.

In Section 625 the bill addresses the matter of instructional and research equipment. I have studied the topic and written extensively on it and append a recent editorial from one of the leading scientific instrumentation magazines. I believe that the danger of throwing money at problems is already proven here. First and foremost no one has established what level of equipment is optimum for what institution. Second, I have shown that just adding high-priced sophisticated ($400,000?) instruments can financially and intellectually cripple many departments. The recent Defense department exercise provides a total of $30 million in grants. In 1982 DOD received 21 times as much in proposals as it had to give out. In effect this means that 20, typically smaller, institutions have each transferred $5,000–$10,000 (irretrievably wasted in preparing proposals) on one large university, which may or may not really benefit. Of course, I support the DOD initiative. It is the absurdity of the selection process that I believe can be improved. In this section it is my considered judgment that this bill could make a unique contribution and be maximally cost-effective by restricting its funding to Section 625(b)(3)—which makes it possible to share well-established existing facilities. Costs per hour are driven down drastically by increasing the usage of central facilities. If this bill encourages this sharing of facilities by any incentives, it will have struck a long overdue blow not only for cost-effectiveness but for breaking down the institutional barriers in many parts of the science establishment.

THE SCIENCE ESTABLISHMENT FLUNKS

(By Rustum Roy)

It has become fashionable—within the space of less than six mounths—for prominent leaders among scientists to be concerned with science education as distinct from research. On all sides we hear of the desperate straits of science education among the general American populace.

By and large, especially in relation to the developed nations, I believe, that the U.S. citizenry and its leadership are indeed below the average elsewhere in a balanced understanding of science and technology and their impact on society. However, the main response of the science community to this situation is an appeal to government and to industry for more money. But nonscientist, politically astute observers detect a peculiar inconsistency in all this recently acquired concern for science education by this community.

How can it be, they reason, that the university science and engineering community should find itself in such desperate straits, when the Reagan administration has been relatively kind to science budgets? For two or three decades, science was well funded; indeed, the seeds of this problem were planted during the plush years of science's growth. Surely money is not the only problem. Is it not in the values and priorities of the scientists themselves?

Have they shown a concern for the education in science of the general public? After all, the Public Understanding of Science program was judged by the science community itself for many years to be worth one-tenth of 1% of the budget of one agency (NSF) and zero in all others. Even the Reagan elimination of the National Science Foundation's science education directorate amounted to only 6% to 7% of the total NSF budget.

DO THEY REALLY CARE?

If, the critics argue, the science and engineering community felt so strongly about any of these aspects of science education, it could easily have shifted, resources during the many fat years of science funding to establish the level of activity that are their new targets.

In the 15 years that the total budget for academic research was growing steeply, the *percentage* of the NSF budget allocated to all science education had dropped from near 50% to nearer 5%. For all those—in Congress and the agency—partly responsible for this change to rediscover education is indeed a turnabout. For them to make the charge that this was due to the "unimaginative" nature of NSF's science education program is ingenuous, to put it mildly.

I believe there is a most instructive lesson in our history of handling science education, and unless and until we in the science establishment radically change our own values (heal ourselves), we will be unfit and unable to mount a meaningful campaign to eradicate technological illiteracy and re-integrate science into the education of all Americans.

The lesson I draw from the facts about our neglect of science education of the general population is that the vast majority of the scientists who have made policy for this nation for the last two decades—as professors, deans, presidents, chairpersons or members of National Academy committees or the National Science Board—did not have any philosophical rationale for or against "science education" for the non-scientist. Most simply didn't think about it or care.

The wholeness of the educational fabric of a technologically advanced culture, from a citizen able to appreciate and criticize technology and science, to the support of esoteric astrophysics Ph. D.'s, was not manifest in the science community's reductionist world view. "More money for research" was the single goal of most scientists and science-policy makers. And when it came to money for science education even of scientists, it was a very poor relation indeed compared to more money for research.

Therefore, it is my opinion that giving a little ($100 million) more money for science education of the general public cannot possibly do any good if it is given through this same community. Its gut-level attitudes simply cannot change that fast. Perhaps a Solomonic test would be to ask NSF, NIH and the rest, in a zero-based budget exercise, to see what percentage they would be willing to give up out of research budgets for science education. The government should then match that amount with additional money for science education within that agency. This would provide a mind-focusing exercise and a cathartic self-healing via repentance for both the science community and the nation.

To improve a very bad situation, I believe the executive or the Congress can move fast via a different program in a different agency, and one which has an excellent antecedent. I note first that it is genuinely in line with the concept of the new (or old) federalism. A new initiative on nationwide technological literacy could be modeled on former Assistant Secretary of Commerce Herbert Hollomon's invention: the State Technical Services Act (STSA).

I propose that an analogous State Science Foundation Act (SSEA) be enacted with two components. One will provide (on the basis of a formula incorporating the number of school students, high-school graduates, two-year technical graduates and college degrees) a grant to be matched on a three-federal-dollars to one-state-dollar basis, for state-run programs designed to eradicate technological illiteracy and upgrade science education for the non-specialist at every level.

VOLUNTEER CONTRIBUTIONS

The second part, somewhat along the lines of the STSA, would provide federal grants with an even higher matching ratio to consortia, regional associations and national groups, for programs agreed upon as being of value to any group of states.

Such programs might involve, for example, development of course content and teaching materials for print or TV. Using block-funding mechanisms, perhaps a five-person federal bureaucracy could run the whole office out of the Commerce Department. Moreover, by having 50 states run the SSEA program, we would move the action away from the research-oriented Washington bureaucracy, toward the level of government that in any case has the responsibility for much of science and general education.

Due to the shortage of science teachers nationwide, the only mechanism for rapid improvement of the national posture is through the volunteer route. The vast majority of our school districts could find in local industry, community college or university, scientists and engineers who would give up several hours a week to teach science at the local school and help in local cable TV, newspaper or other community programs. Such volunteer contributions would count as matching money in kind, to qualify for extra state grants. Moreover, this scheme would not disturb the basic structure of the existing science teachers' employment, while permitting a gradual expansion of the personnel capable of explaining and interpreting technology in the context of society.

The bottom line comes down to this: In an era of fixed intellectual and financial resources, can the high science research community be entrusted with the science education of the American people?

Mr. Roy is director of the materials research laboratory at Pennsylvania State University, and chairman of the university's science, technology and society program. He is at present a science fellow at the Brookings Institution.

STS—CORE OF TECHNOLOGICAL LITERACY

(By Rustum Roy)

Fads are always dangerous. But a fad in an important area of long-term policy is doubly so, because fads by their very nature are shortlived. The sudden hue and cry being raised about "technological illiteracy" in the United States has all the makings of a faddish response to an extremely serious problem. The evidence that suggests, this is simple enough: The same problem has been known for two decades. How can it be that the very large number of distinguished scientists engineers, university presidents and government administrators who now appear on various podia to advocate the immediate abolition of "technological illiteracy" had never mentioned the very same topic in the previous 20 years while they had control of money and policies directly bearing on the issue?

What has caused this heightened response to the new "crisis"? In the U.S. two major events stand out. The first is the virtual abolition of the National Science Foundation's Science Education Directorate by President Reagan, and the loss of revenue to many universities whether or not their work had any bearing on technological literacy. The second is the effort to explain the relative decline in U.S. civilian technological dominance of the world markets. Causes and explanations of the situation are often linked to oversimplified correlations with either the cessation of growth of basic research budgets or the 20 year decline in national average Scholastic Aptitude Test scores.

The faddish nature of this response is nowhere revealed more clearly than in the inverse correlation of the latter two variables. The decline in SAT scores (and indeed the decline in Science Education budgets from 50 percent to 5 percent of the total National Science Foundation) started while basic research funding was in its heyday. Even more frightening, perhaps, is the nearly comical rush towards something called "computer literacy"—presumably a kind of advanced typewriting which is supposed to create an understanding of technology among the liberal arts students, and similar disadvantaged minorities.

If technological literacy means effective linguistic ability in a world dominated by technological impacts, then surely illiteracy must be blamed on those who know the language and should be concerned about the spreading its use: the scientists and technologists. Proper diagnosis and assigning responsibility for the present state of affairs is necessary in this case, else we may well turn to cures which are worse than the disease. Already some scientists express the wish for another "Sputnik," so that in a crisis mode the U.S. would pour more money into "science," including fellowships to attract the best students into "science." This is hardly reassuring since it was the Sputnik kind of half-baked response which got us where we are. F. James Rutherford, former head of Education for NSF, writing in the October 1982 issue of "The Forum" points out: "The lesson of Sputnik is its failure to catalyze a broad-gauged and lasting reform movement in science and technology education. Every student needs a good general education and in these times such an education must pay substantial attention to science and mathematics and their applications."

Another datum of interest to those who would examine how well the research-oriented science and engineering community, the only technologically fluent and politically powerful citizens around, attempted to make their fellow citizens literate, is the budget of the NSF's program in the Public Understanding of Science. We note that all the Federal agencies supported basic research in the universities to the tune of over $5 billion in fiscal year 1980. Of these agencies only one, the NSF, had any programs to advance "technological literacy" among adults. The funding of this was $1 million, i.e., less than 0.02 percent of the total.

Over a decade ago, a worldwide concern within the academic community for "technology literacy" crystallized into the movement for Science, Technology and Society (STS) course work as part of the general education of every student. That nearly one thousand programs (of one sort or another) on as many campuses in the U.S. and Western Europe started at the grassroots level without any massive national efforts is the most eloquent testimony to the early recognition of the need for such education. This Journal and a half-dozen like it, form part of the support structure for those involved in advancing technology literacy among the college student population, one of the most easily accessed populations. Our claim that STS is the only proper framework for technology literacy stems from the nature of the case. Clearly a nuclear physicist or molecular biologist narrowly trained in the typical disciplinary, reductionist mold is no more technologically literate than the economist concerned with balances of trade, or a humanist interested in the ruins of Crete.

"Technology literacy" surely cannot consist merely of standard courses in science or engineering—however many are required. Virtually every college degree holder has had them. They are basically left brain stuff. Technology literacy is inherently relational, right brain material showing the connectedness of science, engineering, economics and ethics. Science, Technology and Society in its very name implies precisely that relational aspect of S&T on the one hand, with societal and human affairs on the other. Surely the technologically literate citizen is the one who cannot only handle basic quantification and understand the rudiments of technology but can appreciate the trade-offs associated with a third world country's decision to build a nuclear reactor, or the exquisite ironies in the recent technological successes in "life support" systems just when the movement for dying with dignity and hospices is blooming.

Readers of this journal do not need to be reminded of the nature of Science, Technology and Society. Yet, they may need to play a more vocal role in providing guidance for the now stirring movement for technology literacy. Many of the insights on the content and form of Science, Technology and Society as part of general education are identical with those that show STS' relevance to technological literacy. The editorial in the issue of "The Forum" cited above, summarized it this way: "In a world with increasing technological and scientific complexity, science literacy must be more than the understanding of a few basic principles in the biological or physical sciences. Rather, it must encompass the ability to apply an understanding of science principles, methodology, capabilities, and limitations to the wide range of decisions students will face both as citizens and as professionals."

Science—Technology—Society: Science Education for the 1980's—An NSTA Position Statement

PREAMBLE

Science and technology influence every aspect of our lives. They are central to our welfare as individuals and to the welfare of our society. All around us are examples of the importance of science and technology for production of food, water, shelter, clothing, medicines, transportation, and various sources of energy. There are an increasing number of science and technology-related societal problems as well as increasing societal benefits. Science and technology are central to our personal and cultural welfare *and* to many societal problems. We must insure appropriate science education for all citizens.

However, the quantity and quality of science education for all people are not commensurate with the status of science and technology in society. When one would expect budgets, time spent on science-related subjects, and support for science education to be increasing they are decreasing. At the same time these factors are declining, societal problems continue to require an understanding of science and technology. The burden of response rests heavily upon the shoulders of *all* persons associated with science endeavors—scientists, engineers, classroom teachers, other educators, and school administrators. Many of the problems we face today can be solved only by persons educated in the ideas and processes of science and technology. A scientific literacy is *basic* for living, working, and decision making in the 1980s and beyond.

There is a crisis in science education. The following science-technology-society problems demand immediate attention: understanding of science and technology are central to our personal and national welfare, yet public appreciation of science education has declined; increasing number of individual and societal problems which have an impact on the quality of life are related to science-generated technology; as the impact of science and technology on society has increased, the support for science education has decreased; compared to its recent past the United States has fallen behind in the production of scientific and technological goods and services; and women, minorities, and handicapped persons are under-represented in nearly all professional and technical roles in science and technology.

DECLARATION

The goal of science education during the 1980s is to develop scientifically literate individuals who understand how science, technology, and society influence one another and who are able to use this knowledge in their everyday decision making. The scientifically literate person has a substantial knowedge of all facts, concepts, conceptual networks, and process skills which enable the individual to continue to learn and think logically. This individual both appreciates the value of science and technology in society and understands their limitations.

The attributes listed below help to describe a scientifically literate person. Each attribute should be thought of as describing a continuum along which the individual may progress. The progress of the individual's science education should be equated with progress along this continuum.

The scientifically and technologically literate person: uses science concepts, process skills, and values in making respnsible everyday decisions; understands how society influences science and technology as well as how science and technology influence society; understands that society controls science and technology through the allocation of resources; recognizes the limitations as well as the usefulness of science and technology in advancing human welfare; knows the major concepts, hypotheses, and theories of science and is able to use them; appreciates science and technology for the intellectual stimulus they provide; understands that the generation of scientific knowledge depends upon the inquiry process and upon conceptual theories; distinguishes between scientific evidence and personal opinion; recognizes the origin of science and understands that scientific knowledge is tentative and subject to change as evidence accumulates; understands the applications of technology and the decisions entailed in the use of technology; has sufficient knowledge and experience to appreciate the worthiness of research and technological developments; has a richer and more exciting view of the world as a result of science education; and knows reliable sources of scientific and technological information and uses these sources in the process of decision making.

RECOMMENDATIONS FOR K-12 GRADE LEVELS

Elementary School Science.—Science should be an integral part of the elementary school program. It should be used to integrate, reinforce, and enhance the other basic curricular areas so as to make learning more meaningful for children.

A carefully planned and articulated elementary science curriculum should provide daily opportunities for the sequential development of basic physical and life science concepts, along with the development of science process and inquiry skills.

Elementary science should provide opportunities for nurturing children's natural curiosity. This helps them to develop confidence to question and seek answers based upon evidence and independent thinking. Children should be given an opportunity to explore and investigate their world using a hands-on approach, with instructional materials readily available.

The focus of the elementary science program should be on fostering in children an understanding of, an interest in, and an appreciation of the world in which they live.

Middle/Junior High School Science.

The middle/junior high school science curriculum should be designed to accommodate the needs and learning styles of the early adolescent. Students should be provided with daily opportunities to explore science through reading, discussion, and direct learning experiences in the classroom, laboratory, and field.

Middle/junior high school science should contribute to the development of scientifically literate persons and not simply prepare them for the next science course. National studies have shown that often middle/junior high school science is designed to prepare students for high school biology with no emphasis on physical science. In addition, studies show that fewer than one half of the junion high students going on to high school take chemistry and physics. Therefore, it is imperative that an important thrust of middle/junior high school science be toward the physical and Earth sciences.

Middle/junior high school students should continue to develop science process skills and content. Middle/junior high school science should emphasize the application of both skills and content to the students' personal life situations and enable students to begin examining societal issues that have a scientific and technological basis. Middle/junior high school students need to apply what they have learned soon after their instruction to insure lasting value of the experience.

High school science

The high school science curriculum should enable students to further develop their scientific and technological literacy. Countries incorporating well-designed laboratory and field work help to meet this need.

A balanced core of readers of science should be required of all students graduating of one year of life science and one year of physical science—both taught in a science-technological-society context. The courses should provide students with opportunities to develop skills in identifying science-based societal problems and in making decisions about their resolution.

Students interested in exploring or preparing for careers in science, engineering, or technical fields should have the opportunity to take additional discipline-based courses in advanced biology, chemistry, physics, and Earth science. These courses should be planned and sequented to take advantage of the students' increasing command of mathematics.

Time on science learning

Lower elementary level (grades K–3): a minimum of 1½ hours/week of science should be required.

Upper elementary level (grades 4–6): a mimimum of 2½ hours/week of science should be required.

Middle/junior high school level (grades 7–9): a minimum of 1 hour-day for at least 2 full years of science should be required of all students.

Senior high school level (grades 10–12): a minimum of 1 hour per day for 2 full years of science should be required. The courses should represent a balance of physical and life sciences.

Emphasis on programs for all students

In elementary, middle, junior, and senior high school grades, science education programs should provide basis concepts for all students. Opportunities should be available for students with diverse interests and commitments, including students with exceptional interests and talents in science.

Emphasis on science education for the adult general populations

Schools should provide educational opportunities in science for all the adult population in their community.

Colleges, universities, and national organizations should increase emphasis on science education for adults through public lectures and seminars.

The important contributions of out-of-school education programs such as museums, TV, planetariums, and zoos, should be recognized and utilized by all those involved.

Emphasis on the professional development of science teachers through inservice opportunities

Colleges, universities, and other agencies should develop teacher education and inservice education programs that are consistent with this policy statement.

School districts should provide opportunities, encouragement, and recognition for teachers who maintain a high level of professional competence.

Emphasis of laboratory and field activities

Elementary level laboratory and field activities should stress the development of basic inquiry skills.

Middle/junior school level laboratory and field activities should stress the application and extension and inquiry skills as a measure of obtaining knowledge and resolving problems.

High school level laboratory and field teachers should emphasize not only the acquisition of knowledge, but also problem solving and decision making.

Science instruction matches students' cognitive physical, social, and emotional development

Schools should provide objectives, contents and instructional strategies that are appropriate the student's stage of mental, moral, and physical development.

Varying strategies and materials should be provided at all grades to accommodate student with various levels of learning skills and mental development.

Emphasis on science-related societal issues

Elementary level, a minimum of 5 percent of science instruction should be directed todard science-related societal issues.

Middle/junior high school level: a minimum of 15 percent of science instructional be directed toward science-related societal issues.

Senior high school level: a minimum of 20 percent of science instruction should be directed toward science-related societal issues.

Chairman PERKINS. Now we will hear from Dr. Harold Patterson, superintendent of Spartanburg, S.C., representing the American Association of School Administrators.

Go ahead.

STATEMENT OF HAROLD PATTERSON, SUPERINTENDENT, SPARTANBURG, S.C., REPRESENTING THE AMERICAN ASSOCIATION OF SCHOOL ADMINISTRATORS

Dr. PATTERSON. Mr. Chairman, after hearing this today, I think I am a bit more optmistic than some of the speakers, and I may have to intersperse some things into my comments because I think they need to be said.

One is, I would like to take Professor Roy back with me to South Carolina. I am very intrigued with what he had to say.

I am also here as a member of the AASA Committee on Federal Policy and Legislation, and as president-elect of the South Carolina Association of School Administrators [SCASA]. In those capacities I have heard from many other school administrators concerning the need to improve instruction in the areas of math and science. At the January meeting of the AASA Committee on Federal Policy and Legislation, we discussed the need to improve math and science instruction at great length. Thus the hearing on H.R. 30 today, and subsequent days, is very timely.

We applaud the efforts of the chairman, the committee, and other Members of Congress to address this growing problem.

While Congress is considering this new legislation, AASA believes it is important to maintain a perspective on the Federal role and Federal interest in education. A Federal interest in education has traditionally been defined as including those areas which affect the entire Nation and where the entire Nation has a stake in the outcome. One such area is certainly instruction in math and science at the elementary, secondary, and postsecondary areas.

The economy is changing rapidly and in the next century the major industry and source of employment will be the generation, storage, and transmission of information and people employed in that information society will need different skills and knowledge than workers have needed in the past. Some of those skills and knowledge concern improved education in math and science.

However, a word of caution is necessary. Dr. Roy Forbes of the Education Commission of the States has worked with scholars and industrial leaders to identify skills that future workers will need, and his conclusion is that critical thinking and evaluation skills are more necesary than simply improving students' ability in math and science. AASA urges this committee not to be part of a stampede to alter the curriculum in ways that will not be beneficial to our students in making career choices.

Therefore, we thank you, Mr. Chairman and your cosponsors, for introducing H.R. 30, the Emergency Mathematics and Science Education bill. In fact, we are approaching an emergency situation in many school districts in math and science education. However, the use of the word "emergency" also connotes that the funding proposed in this bill is inadequate to the task of improving math and science instruction. Because the budget deficits are so large, there can be no contemplation of programs large enough to actually address the total need.

The authorization for part A of H.R. 30, $250 million, is not enough in our estimation to meet the total need. If there are approximately 50 million schoolchildren in America, that would be only $5 per child if all the funds went directly to local education agencies.

NEA said six, they probably are right. I have been thinking about that since she said that.

Because funds are limited AASA recommends that the committee consider targeting the funds to needy school districts for specific purposes. First, we recommend that the funds be targeted directly to local education agencies. We do that because the research shows that if inservice education is going to work, teachers have to buy into that process. Teachers know what they need better than I know what they need as a superintendent of schools, and better than the Federal or State Governments. So the inservice programs have to be tailored to the needs of the teachers.

Second, we recommend that the funds support only two goals: First, to increase the supply of teachers in math and science and, second, to upgrade the skills and knowledge of teachers currently in the field. There are several ways to meet our short-term needs for an adequate pool of qualified teachers for math and science.

First, to retrain teachers from other areas who are losing their jobs because of a decline in student enrollment; second, to review the pool of substitute teachers and other persons qualified to teach but who are not currently teaching; third, to provide incentives to undergraduate and graduate students to train as math and science teachers and actually go into the classroom instead of industry; fourth, to work with the business community to identify qualified and interested personnel from the private sector to teach on a part-time or a full-time basis in the classroom and to provide teachers with summer employment to cover the salary differential between industry and education; fifth, to structure teacher certification in the math and science areas to account for differentiated qualifications.

Right now you have to have 24 to 30 hours of science to teach general math. That seems to me to be a bit unusual. We might not have as much shortage if we could target people to teach the subjects which they can do best. So we need to look very much at how we certify in differentiation. As a matter of fact, we do that in the area of science.

Because the amount of money available is relatively small, it seems that spending funds on curriculum development or curriculum analysis is an inefficient use of these funds, because the curriculum, no matter how good, is no better than the person providing the instruction. Therefore, funds should be used to develop the most important element in the instructional process, the teacher.

The corollary to these recommendations is that not every district should receive the same amount of funds.

I come from an unusual district. For example, my district currently has no math teachers or science teachers on emergency certificates. In fact, we have an excess of applicants in math and certain science areas, that is, biology and general science. However, that is not true all over the State of South Carolina. There are some districts in South Carolina in which a majority of the schools have in excess of 10 percent of the total faculty teaching on permits or emergency certificates. Those districts need a greater proportion of the funds than my district.

The task in Spartanburg is to assure an adequate long-term supply of math and science teachers and to provide funds to upgrade the skills and knowledge of teachers currently in the classroom. Therefore, AASA urges the committee to consider targeting not only on the basis of the number of disadvantaged children, which is a very reasonable criterion, but also the number of teachers on emergency certificates or teaching out of their field as criteria for distributing funds.

As an aside, we have just done two studies in South Carolina reported to the State Board of Education 1 week ago last Friday. In the math area, we had last year certified 50 math teachers that were graduates of colleges or universities in State. We had 57 that were certified, issued certificates, that were from outside of the State. The interesting thing about that, of that 107, only 42 went into teaching. A third more of the out-of-State graduates went in than did the State education graduates.

Let me speak specifically about our high school.

We currently have 12 math and science teachers who could remain with our district from 1 to 25 years. We have an advanced placement biology teacher that will probably retire next year. Now that may be difficult for us. But right now, out of our 19, they are teaching a total of 1,195 students, that is 53 percent of our high schools. Now, please be reminded that does not include basic math, general science, earth science—we have another title that has a number of sections which is less than the algebra 1 track.

We also offer computer science, and plan to this next year have an advanced placements computer science. But these youngsters are going from Algebra 1 to advanced placement classes in physics, chemistry, biology, and calculus, which is a 5-year course. If we are to retrain these teachers, we must raise salaries, enhance the image of teachers, and reestablish the importance of education in developing the potential of the young people of this Nation.

I believe Congressman McCurdy, I would invite him to Spartanburg High School, and any of you. But before you believe that

American education is as bad as some comments that have been made here today, and including math and science, the next time you are in your district visit a high school and visit some math and science classes. They are not as bad as I have heard stated here today. We have difficulty, but not nearly what I have heard here today.

I challenge you to get into a few of those classes and see if we don't have some competent teachers doing an excellent job of teaching math and science. Again, over the State of South Carolina, we had people with minimal skills, even those who were not fully certified, were teaching math and science. So we really need to be sure of what we are doing.

The bill should allow school districts the latitude to provide inservice training within the district, to acquire inservice training from consortia, or colleges, or to simply pay tuition for individuals to further their education.

In terms of assuring a future supply of teachers, the congressional scholarship mentioned in part B of H.R. 30 is one method. Another method would be a loan forgiveness program which should be included in H.R. 30, although there are administrative problems with that approach.

A third method, which AASA favors, would be a direct grant from school districts to persons who would train to teach math or science. The retraining and development grants might be named after H.R. 30 or its sponsors, similar to other Federal grant programs.

We have to establish some prestige back to education. Teachers have to have some prestige restored. The great majority of them are better than the public press which they receive.

Who would receive the grants? Recipients could include students in undergraduate school, persons who have a college degree who would like to become math or science teachers, persons who currently teach in another area who would like to teach science or math or persons who have lost their jobs during the current recession.

The pool of recently unemployed is mostly blue collar but the educational potential of that pool is enormous. One can reflect on the post-World War II era and the GI bill which allowed many persons who had never planned to go to college to receive a college degree. The academic records of these students offer substantial proof that the blue-collar worker pool has significant untapped educational potential. Extra effort should be made to attract women and minorities into this grant program.

At the last meeting of the AASA Federal Policy and Legislation Committee, we heard that black colleges in the South which had traditionally provided large numbers of teachers were no longer supplying a significant number. As a matter of fact, it could be stated they are supplying an insignificant number. This has potential for long-term negative impact, especially in urban schools with the largest majority of minority students.

H.R. 30 should encourage small school systems to work together in consortia and/or with the State Department of Education to provide training and to provide an adequate long-term supply of math and science teachers. AASA suggests that Congress encourage such cooperation by not making grants to schools or combinations of schools with the enrollment below 1,000.

Evaluative criteria should be included in H.R. 30, and those criteria should be related to the goals of the bill. Thus, AASA urges that the supply of math and science teachers and the upgrading of skills and knowledge of current math and science teachers be the basis for judging the success of H.R. 30.

Some may call for an increase in the number of units in math and science as a basis for judging the success of a math and science program. That approach will introduce new expenses to schools because new science requirements require new labor and equipment. For example, adding one science credit to the graduation requirements of the Jefferson County, Colo., schools necessitated building a new lab in every high school in the district.

AASA further believes that this committee should support section 624 of H.R. 30 which directs the National Institute of Education to study the area of math and science, to determine how many math and science teachers are required, what curriculum deficiencies exist in math and science, and to determine how computer and communications technology works best and with what students and academic areas.

Finally, for any advances to be made in American education, Congress must recognize education as the priority and avoid establishing the teaching of math and science as the priority. For the past several years, although Congress has been active on education legislation, education certainly has not been a priority either of the Congress or this administration. One of the key elements of the survival of our Nation is an educated citizenry. Congress cannot afford to ignore education. This does not necessarily mean massive infusions of new money, it does require the consideration of the role of education in the development of national fiscal, industrial, and defense policies.

Thank you for the opportunity to address this committee. I will be happy to answer any questions you may have.

Chairman PERKINS. Thank you very much, Mr. Patterson. I presume you agree with the National Association of Secondary School Principals that the funds should be channeled directly to the local school districts instead of going through the chief State school officers; am I correct?

Dr. PATTERSON. Yes, sir, I do. I would also say, Mr. Chairman, Mr. Thomson served in a school which I served there prior to his going. I served in one high school in Alabama, one district in South Carolina, and another district currently that has for years provided summer incentives, summer workshops, and we currently have at least five teachers who will be doing that this summer. It is not unusual for that to occur in many schools throughout the country, but we all have money problems, as you pointed out, so this would be an incentive for us.

Chairman PERKINS. Mr. Thomson stated we had the infractructure already in place. We would not have to set up any new agencies at the State level or anything else. They could serve as they do in title I, with the funds flowing through the State agency to the local State districts.

Dr. **Patterson**. Yes, sir, I do not want to pick on the States. We do not want any more Federal agencies, either.

Chairman **Perkins**. Mr. Goodling.

Mr. **Goodling**. I thank everyone for being so patient this morning. I am sorry that my colleagues took so much of your time. The testimony that you offered gives us a lot of food for thought. As I indicated from the beginning I got on the legislation as a start, not that we had some kind of proposal that was ideal, but that this was a place to start to begin the testimony.

Mr. Thomson, when you said you do not want to get into the business of a differential in salary, I trust that you were not including a performance incentive in that statement. If so, I was going to ask Miss Futrell for her organization to provide some leadership to keep good teachers in the field. Contrary to what some of my colleagues think, their salary is not the only reason they leave. There are many other reasons. Part of the reason they leave is because Joe Blow next to them does not teach much but gets the same salary they get. You do not want to say math teachers get such and such as a starting salary and science teachers something else?

Mr. **Thomson**. That is correct, sir.

Mr. **Goodling**. I want to also mention that Professor Roy did not mention this, but I want to mention it. He is from the Pennsylvania State University, and I want to mention it to show you that we are No. 1 in more than football, and I think he is a prime example of that.

I do not have any specific questions because, as I said, I want to digest all the suggestions and ideas that you have as to how we can better write this particular piece of legislation, keeping in mind the limited funds that will be available so that we can make sure that when we report it out, it is not just something that has mass support. As you people pointed out by your testimony, whenever we try to bring a consensus, it is a very difficult thing to do. We want to bring out the best piece of legislation we can. I think that all of your testimony will certainly help us to do that, and I appreciate it.

Chairman **Perkins**. Mr. Williams.

Mr. **Williams**. Thank you, Mr. Chairman.

I appreciate hearing the testimony from most of you. I apologize to a couple of you for having to visit with some constituents in the other room during your testimony.

Mrs. Futrell, I bring greetings from John Board, your colleague in Montana, and my friend.

We all agree that this problem is one that ought to be on the Federal agenda. We do not quite agree on the solution. It should be on the Federal agenda, we are in agreement with that. I am going to have an amendment to this bill to solve what I think is a—is part and parcel of our problem here. I believe there is an insufficient understanding among the public of the value of math and science curricula, an inadequate appreciation of the importance of appropriate math and science education, excellence in math and science instruction, and of the role played by mathematicians and scientists in our society. My amendment will require the expenditure of a given sum of money for the purpose of trying to heighten the public's awareness of the values of math and science and the necessity of first-class math and science instructors. Mr. Roy, if that 1 percent is going to float or perhaps be the shock absorbers, the other 99 percent needs a full awareness and appreciation of the value of math and science, and perhaps one of the reasons that we have come to this dilemma is because the public has not pushed us to stop it from happening. I am hopeful that when you see my amendment, and I will see that each of you have a copy of it within the next few days, you will be able to lend your support to it.

Thank you, Mr. Chairman.

Chairman **Perkins**. Let me comment. Of course, if the public is unaware of the math and science inadequacies in this country, especially in our schools, it is really difficult for me to believe that they do not realize the full consequences of the inadequacy of these courses. We have been on this problem since 1958 with the National Defense Education Act. We have deviated to some degree in the sixties, when we tried to cover the waterfront with the National Defense Education Act, broadening the programs to include the humanities and everything else. But with such little funds here, and Mr. Williams, I just dont know if this is an appropriate use, I have got nothing against the wisdom of spending any money to advertise the necessity in what we are trying to do throughout the country. I think every local educational agency is fully aware of it, and if the leaders are not aware of it, this country is in terribly bad shape anyway. If we had money, I would certainly afford to see some of it used in this way, but we are penny-pinching here in this thing anyway. Maybe Mr. Miller may know more about it than Carl Perkins. Let us let the gentleman from Brookings Institution comment.

Mr. **Roy**. Mr. Chairman, may I suggest that the public is not as sophisticated as the chairman of the Education and Labor Committee. The Members of Congress are aware of national needs, and I am afraid that Mr. Williams is on the right track in saying that if the public were made aware, they would generate the funds at every level, they would do the pushing in order that we could get the kind of attention.

Let me cite data from this morning's television program. The taco industry of the United States, the Mexican fast food chain industry increased to $1.25 billion in the last 2 or 3 years. We have among economists and the general public an awareness that any source of employment is equal to any other source. I submit as a technologist, as somebody working in science policy, that the public has gotten a very skewed view of the economic and technological base of the Nation, and I think that anything we can do—I am sure it is not going to take millions of dollars, but the whole connection of society's health with its technological base——

Chairman **Perkins**. The question is, is it worth it?

Mr. **Roy**. Beg pardon?

Chairman **Perkins**. With the shortage of funding, is it worth $20 million to advertise?

Mr. **Roy**. I hope it would not be advertising. I hope it will be material which goes into the high schools, as science, technology, and society. The children's parents who see that connection, instead of being baffled by the mathematics which the kids bring back——

Chairman PERKINS. What do the chief State school officers think about it?

Mr. RAYNOLDS. Mr. Chairman, I have been breathless about the business of getting into an argument about where the money goes. I would like to restate a view that I feel very strongly about. If the Association of School Administrators or the principals or the teachers are deeply concerned that some of the money will get stuck in a growing bureaucracy at the State level, I would like to make a suggestion along those lines—I made two in my testimony—to avoid the concern that this is just going to fill up a bureaucratic kind of need, hiring more people, et cetera.

My concern is that in my State the great majority of the school districts have fewer than 1,000 children. That means—and this is characteristic of many parts of the Nation—if you get $3,000 in that district and you have the option of doing the five things that are listed as a range of concerns, including buying some equipment, my real concern is that that may not really impact very highly. Likewise, a per capita distribution of dollars from any of our perspectives in effect going to Spartanburg where the gentleman says that the need for science and math teachers is not as great as in some other areas of South Carolina does not impact well.

So our two suggestions were, careful targeting of ways which will leverage other money, $250 million we have all agreed is not enough. So we need that as our No. 1 aim aside from all these other issues. If there should be concern about the growing bureaucracy at the State level, I would put a proviso on the bill that none of the State funding can be used for the hiring of personnel, only for the distribution toward grants and workshops, institutes, those kinds of things. There would be an advantage for many of our smaller communities if they had an incentive to meet with each other and the State try to be the convenor without adding to the bureaucracy, those districts getting $3,000——

Chairman PERKINS. What is NEA's position?

Ms. FUTRELL. Let me respond—I think in 1957 Sputnik catapulted us into the national crisis dealing with science and technology and where we were dealing with that whole issue. My personal opinion is that we probably would not get very far by spending $20 million on advertising. I would prefer to see the money go into the program so that it goes back to the schools and that the children and the teachers will receive it. I think the best advertising we can get, and we got some of it last night, and it was about time, was when the President included it in his statement and let the public know, those watching, that we are facing a crisis in this particular area. So my preference would be, and NEA has not seen this, so I am speaking as an individual, put the money into the bill and use it to help the children and help the students.

Chairman PERKINS. The Association of Secondary Principals, what is your view?

Mr. THOMSON. The public is more aware of the problem today than 2 years ago. Every time you read about Japanese stealing IBM secrets, that has raised the level of awareness on the part of the public, but I do not think the public is as aware as it should be. We are halfway, two-thirds of the way there, I do not know how far, but substantially along the way. It seems to me that the private sector has a role here. Many people across the country, influential people, receive annual reports from business and industry. Perhaps the chief executive officers of the corporations of the country ought to be talking about this problem. Maybe some kind of a matching grant basis where private sector would put in as well as the public sector. But by and large I think that the media has done a good job of bringing this situation home to everyone.

Chairman **Perkins**. As a public service for the Nation?

Mr. **Thomson**. Yes.

Chairman **Perkins**. Dr. Patterson.

Dr. **Patterson**. I see two different things. Advertising, I would not want to spend that much money, but I believe Professor Roy is talking about a different kind of an awareness program or an impact on curriculum. If we are talking about fusing some math and science with the society realm, which I understood him to say, I think there may be some need to do that. I do not know how much money would be needed to do that, but there probably is something that needs to be done with that.

Again, what the perception of the public about schools is simply revolves around their child or children. One of our major problems today is we are down to where there are only 30 percent of adults with children in schools. We are dealing with the patron question where 70 percent out there do not have any involvement. They do not know what is going on, what schools are doing. If they perceive it—we all tend to perceive things in their worst light. We are critical of each other. That is why I do not want to argue here about where things ought to go. We believe that there is not enough money and the impact has to be on teachers. It cannot be on districts or students, it has to be on teachers, because that is our crucial issue.

Now curriculum, basically we have good math and science curricula. We can go back too, we still use certain pieces of curriculum developed in 1958. Who does not use in some honor classes BSES, and it was a part of that process. That does not mean it does not need to be updated, too, but that can be an ongoing process. It is not something this bill can manage in terms of the funds needed, but I would support some kind of fusion because I think it is necessary.

Chairman **Perkins**. We better bring about all this public awareness through public-spirited educators asking the networks and the local radio stations and so forth to give publicity to the value of a program of this kind.

Dr. **Patterson**. The most logical way to get everybody's attention is to put it on the Saturday morning cartoons. If we can get somebody to deal with that issue, we will get it across to the youngsters of this country.

Chairman **Perkins**. Mr. Williams. Excuse me for interrupting.

Mr. **Williams**. Well, I appreciate the benefit of that interruption, Mr. Chairman, and I will take the wisdom of the panel members and of course the good wisdom of the chairman and assure you that I will draft this amendment in such a way that it avoids hucksterism, and I will take the suggestion, which is a good one, to encourage the private sector to help us with dollars. I will be certain that the amendment benefits teachers, math and science teachers. We will encourage the taking advantage, as the chairman has suggested, of the public media, such as public radio and television. Of course, I will accept the wisdom of the chairman who says $20 million is too much and I will reduce the amendment to $5 million, which is about 10 cents a student, less than the price of a taco.

Chairman Perkins. All right.

Mr. Boucher—excuse me, the gentleman from Texas, Mr. Bartlett.

Mr. Bartlett. Thank you, Mr. Chairman. I do have some questions. For some of us $5 million may be too much, also.

I appreciate the panel and the expertise that you provide here today. I am a new member of the committee, and if you will indulge me, I have several specific questions which I would like to get in the record and get your judgments on.

I assume this one would go to Mr. Raynolds, or perhaps Mr. Thomson or Dr. Patterson might want to comment. In view of the crisis and the emergency nature of the shortage of math and science teachers, as I recall last year some $480-some-odd million was made available but was converted into a block grant back to the States. Using that block grant money and other resources do you have any way of quantifying how much additional funds have been prioritized by States using those block grants into math and science?

Mr. Raynolds. I have no way of making any response to you about the Nation in general. For my State, which is certainly typical, the block grant which we took and used just as the segment to the State, which we used exactly as I suggested here, not to hire personnel but to utilize for workshops, the amount of money that we had, which was $200,000 roughly in the State of Maine, generated a considerable amount of extra money because we used it to make collaborative arrangements with the universities. The schools in our State, for example, are spending $450 million, spend $5 million per year on in-service programs. From my perspective, much of it is not well spent. I am not the person to make that kind of a decision. They decide that on their own.

My concern is how do we put together the $5 million now there in local school budgets without 1 penny from Congress with the $200,000 that we use to leverage some of that $5 million to put together projects which we were able to get collaboration with the university. That is the fine art of doing what we have to do, bringing the various resources together and working with them. I cannot answer better than to say that probably the $200,000 mixing with another $1 million from local school districts in the State of Maine by way of example provided the basis for special programs in such things as science, math, English, the humanities, teaching of writing, and so forth. That is what I talk about when I use the word "leverage."

Mr. Thomson. The incentive program that we were interested in in the last session of Congress and this session, to provide loan forgiveness for math and science majors going into teaching, and this loan forgiveness would equal the tuition and room and board for teachers. We estimate—we estimate that the first year would be about $12 million for those entering 1 year, and after 4 years it would be approximately $48 million to $50 million per year.

Mr. **Bartlett**. I am aware that in my area, and I know in your area also, school districts seem to be tackling rather handily—on a priority basis—the shortage of science and math teachers through bringing in private sector employees and making other innovations. Do you have any way of quantifying what the school districts that you represent have already done or are doing now?

Mr. **Thomson**. I do not have a figure.

Mr. **Bartlett**. I believe you have some very good recommendations in your testimony. As you read the current construction of H.R. 30, are you suggesting that your recommendations are already contained in the bill, that each of these recommenations such as urging the committee to include a major component for in-service training and to enable administrators to purchase equipment and to retool and to repurchase incentives for business are permitted under this bill the way it is constructed now?

Mr. **Thomson**. Most are included in H.R. 30, but not all. For example, H.R. 30 recommends I think a 10-percent forgiveness loan or what amounts to essentially about less than one-half of the cost situation of board and room. We suggest that full reimbursement for board and room be provided, for this reason, that that amount of subsidy plus the salary that a teacher would get out on the job the first year and the second year, together with the subsidy and the salary would just about match what that person could probably make in the private sector.

Mr. **Bartlett**. Would you urge us to construct H.R. 30 so that when a school district receives this grant, the school district could go and repay the tuition if they chose for new teachers, using its own local discretion?

Mr. **Thomson**. The individual would have to repay the loan if he did not go into education. The Federal Government would be repaying the loan if the person did go into education.

Dr. **Patterson**. I happened to be in a committee meeting yesterday where a teacher pointed out, she is an eighth-grade math teacher, and she said that in order to meet new certification requirements it was going to cost her $3,000 to go to school, because she worked in the summer and made $1,500. She was going to have to drive a long distance, like 100 miles either way, to get a course required for certification. She said people must be dumb to think that we are going to continue to do that when we can go to industry or business and make more money than we are currently making. That is the incentive. We need to make it attractive when we need to upgrade skills.

Mr. **Bartlett**. As we construct this bill, would you urge this committee to be permissive and allow school districts to use the money to construct programs, to increase the number of math and science teachers, to correct a shortage of equipment, that is, just let the school district decide how best to do that, or would you urge us to establish specific directives on how school districts should spend their grant money?

Dr. **Patterson**. We want to target teachers, and we do want leeway within that realm. I personally do not believe there is enough money to buy new equipment, because mentioning a school of 1,000 or a district of 1,000, you simply are not going to have enough money to buy one computer, and if you do you will not have software and you will not have staff members that know how to use it, so it will become a toy. We do not need to do that and then be criticized for not doing valid math and science work.

Mr. **THOMSON**. I have made six recommendations for legislation and did not say this, but they were in order of priority as I would recommend them. I think the most important step would be to provide incentives for math and science majors to enter teaching, and I think that the second most important step to take is for incentives to remain in teaching, and that does include summer workshops and so forth as well as other forms of summer income.

Mr. **BARTLETT**. Would you structure the bill so the school district could use this Federal money to supplement a teacher's income to pay additional salary?

Mr. **THOMSON**. No; I am very much opposed. The secondary school principals of the country are opposed to having first-class and second-class teachers. We think that they should be paid comparably during the school year, but we do support incentives and additional salaries during the summer for work in the field of science or math.

Mr. **BARTLETT**. That decision is to be made by the school district, though?

Dr. **PATTERSON**. We would support that because we believe that the money should be spent to either update skills or increase or bring in new teachers.

Mr. **BARTLETT**. Dr. Patterson, he would not let your school districts buy equipment with that money. Would you?

Mr. **THOMSON**. Yes; I disagree on that particular issue, although it is a low-priority item for me, the higher priority being recruitment of teachers, training of teachers and retraining. I would place equipment at the bottom of the list. It is a problem, though. As long as we all understand that then we understand there may be higher priorities for the money, then that is fine, but it is a problem.

Mr. **BARTLETT**. I thank the chairman and the panel.

Chairman. **PERKINS**. Mr. Boucher, go ahead.

Mr. **BOUCHER**. Thank you, Mr. Chairman. I would like to say that I am very pleased that Mrs. Futrell could be with us today. When I first met her I was a newly elected member of the Virginia State Senate, and she was providing very distinguished service as the president of the Virginia Education Association. I guess I learned education from her at that point in time. So I would like to join you, Mr. Chairman, in welcoming her here today.

Chairman **PERKINS**. All right.

Mr. Miller.

Mr. **MILLER**. Thank you, Mr. Chairman. One of the witnesses testified you have 19 teachers who would be with your school district possibly 25 years—does that mean all 19——

Dr. **PATTERSON**. I said the 19 would average. One will retire next year. The range is from 1 to 19, so probably the biggest problem is the youngest teacher on my staff teaches two very competitive courses and AP courses, and he is now being trained and will go to school this summer to teach an AP computer course. That is advanced placement. As soon as he gets trained, look out. I will be looking for another teacher, because he can—somebody is going to offer him two or three times. See, one of the big problems with technology for schools now, we have hardware. Software is simply almost nil at this point. That is one of the problems we face. If you are going to put any money into the equipment arena, put it into software development.

Mr. **Miller**. Let me ask you, one of the questions I have is whether this teacher leaves because he is going to be so well qualified that industry is going to take him away from you in the private sector. Assuming that we had these superqualified teachers emerging from the better education system, I just wonder how many you could absorb each year. You know, the NBA basketball teams take 1.5 rookies. We graduate 50,000 people who would like to play in the NBA. In a school district of 1,000 people, how many new teachers would they absorb because of tenure loss, contractual arrangements? It is a career, teaching, for those people who are there. They may decide to leave, but I just wonder what we are talking about in terms of matching part of the solution to part of the problem.

Dr. **Patterson**. The State of South Carolina just completed that study. We have approximately 33,000 to 35,000 teachers in the State, and we estimate that next year we will need 170 math teachers. That gives you some idea of the replacement that is going to be needed and that probably—it may be large, because you know small school systems and rural school systems have great difficulty because they get a teacher that will come and teach for 30 years. When they leave it is a real recruiting process to try to get anyone to go, because they generally do not pay as good salaries and all kinds of things.

Mr. **Miller**. The rate of turnover at which point you get 100-percent turnover, it is a little like dealing with well, babies. Once the pregnancy has started, you have a finite period of time. Children have entered school. Now, so you have a level of time here. It seems to me that if we wait for the superteacher with the superincentives to solve the problem in terms of new graduates, we are losing children each year, and if you have that—if that is a typical turnover, it would seem to me that the concentration of resources as many of you have suggested is in-service training. We have to deal with the teachers we have now—I happen to agree, they are better than they get credit for, but in a political system, in an economic system that continuously talks about the American system where incentives drive you on, they have about hit the brick wall in terms of incentives, and so I wonder—we go back to these figures in this legislation of $3,000 for this district or—you know really it is a very small impact. It gets lost and we have differing opinions.

Then the question that was raised by Mr. Goodling of the salary differentials. I am very concerned that my child can read before I am concerned they can do computers. But it seems to me we have to talk about the system that is laid on top. I cannot change the tenure laws, I cannot change the negotiated collective bargaining agreements, I cannot change the politics of the district, but what I am concerned about is that somebody, and I happen to believe strongly in the school-site principal, have an ability to nominate people whom he thinks outstanding for a summer scholarship or for 6 months away in-service training in advanced work and start to try to make some of the roses bloom here. Just to put $3,000 in a district, you can buy the Apple II and as you point out you end up with no software. I do not know what we have done. I think Dr. Roy's point, we need some steam—one of the things we are trying to work in my district is if the school district can come up with $2,500 for the summer can we get the oil refineries in the district to come up with the other $2,500, because this teacher will be coming back to a voc ed program, allowing them to find people in local districts.

Mr. **Miller**. I am really concerned that we not shotgun with very, very few resources, at least now we are talking about—maybe the President's speech will help and we will get $1 billion quickly, I doubt it—that we concentrate where we can do it with these kids.

It seems to me that loan forgiveness is very important to assure teachers to take other teacher's places, and that ought to be done immediately, so that students making decisions who are already in institutions of higher education can start working, figuring this will be good for them for maybe 8 or 10 years.

But the concentration, it seems to me, has to be on the elementary and secondary teachers who are there. Teachers I know don't plan to retire. I read about everybody getting taken away. I am sure the flowers are picked from among the weeds or something. But I don't think it is the general rule.

The other thing, it seems to me, this idea of engineering. As I understand it, having just sat down with the son making out applications to college, most of them are closed. They are running at capacity. Maybe they have had the capacity reduced because of funding problems.

But computer science programs are closed unless you applied the first week, and engineering programs are closed. That upper 1 percent, I think, has already enrolled. Maybe forgiveness will get them to go into teaching. But that doesn't seem to answer the question for my other son, who is in junior high. I am more concerned about the teacher that is going to be teaching him next year and the next 4 years.

To suggest that we are going to formulate this money out on some kind of equitable basis per school district, it seems to me you might as well drop it out of an airplane. I would love to have your response. But I just think we have a lot of politicians running around saying the sky is falling, and I already see the parents pushing the kids.

I think parents are already saying to young children, and young children are becoming interested in computers, that that process is going on. I see the universities full of engineering computer science, computer related courses being filled to capacity. It seems to me that problem is being addressed. We have a void for the people in the trenches who are dealing with the in-betweens, if you will.

Dr. **Patterson**. May I speak to that?

Mr. **Miller**. Anybody.

Dr. **Patterson**. You are right. We are going to have to deal with the current people. We are doing that already. What we could do, if we got some money, is do it much more quickly. As has been pointed out, in Maine you have $5 million. Now, that $5 million is being used. This is seed money. You have to understand. It will be used as seed money.

The real problem is the teacher that we have three classes running now with a program, out of the school district office, teaching teachers, because we are moving into that. Every administrator is going to have to go through a basic course of understanding that, because we don't know anything about it, we can ask the right questions. So it has got to be done with major in-service kinds of things.

I certainly agree, you are not going to rock any boats with $3,000. If you got all of the money in your state, you would not have enough to provide very many full scholarships. There has got to be some way that it reestablishes—but again the thing we have got, we have spent a lot of money on bringing in the expert 50 miles away. What we are finding in my school district is a good science teacher is doing a lot of in-service with other science teachers, because that science teacher is up on that one thing that we need at that point.

We are using the money to provide materials. We don't even pay a consultant. We don't even pay an outsider. We use it where we have it. Then when we have to, we go to the State Department or to the one, two or three universities near us, and we get the people and pay them very minimally to do what needs to be done.

Mr. Roy. Mr. Chairman, I would like to respond to this also.

Mr. Miller was going to throw the money out of the airplane. I suggest what my colleague just mentioned is a better solution. There is one point. I studied the question of leverage in education. One high leverage point is in the materials.

I suggest I cannot help Chairman Perkins, but there is a jurisdictional solution to the relationship with Mr. Fuqua, and that is in the preparation of good materials. You know you have no software. You have a lot of leverage on the preparation of materials. Today we need materials in all the new areas.

I want to suggest that what my colleague, Mr. Patterson said, is termed diffusion into the curriculum. I don't want to advertise in the newspapers. I am talking about curriculum materials being given to the teachers. That is the highest multiplier we can possibly get.

You get good people, but to plug into them materials, which is a national problem.

Mr. Miller. Let me interrupt you there. I came on to this committee afterwards. I have always been worried about it since then. When the Federal Government discovers a problem and puts money into the system, you create an industry that tries to fill that void.

One of the things that really concerns me is coming on after with equipment. That was the big key to title I. I started touring schools where tape recorders were in boxes and audio visual equipment and filmstrips and everything else. I don't want to go through that again.

I don't think we can afford to, especially when there is such promise in terms of new curriculum in this area, especially with respect to software. I really don't think this committee is interested in creating an industry for the sake of creating the industry.

We are very interested in building upon some substance within the new curriculums to be made available.

Mr. Roy. It is precisely the opposite. I hope nobody is giving tape recorders out. Our concern is all public domain informational materials, and by materials I mean what is the nature and substance of a curriculum.

In my science, technology and society materials we have nothing for the high schools, zero. The British Government has complete curricula. The Japanese material is complete. We have nothing.

Now, I think it should be all public domain. I don't feel we should create industries, I don't feel we want black boxes.

What are we going to teach. What is the substance of what we are going to teach. The software, as you say, for education, if it is created with Federal funds I believe it should be put in the public domain. The university professor shouldn't get any money out of it. I feel if it is done with federal funds it should be done for the public domain.

If the person takes the money and wants to use it, he should be willing to put it into the public domain.

Mr. Bartlett. To follow up on that, what would this bill do? It would redirect curriculum so the school boards would be told what to teach, or just teach more of math and science?

Mr. Roy. The specific point I addressed was the new glue for increasing public awareness, and I mean support, and for the high school students and the elementary schools to retain their interest is the subject matter field, which is brand new. It is called science, technology, and society. It links that.

What I suggest the bill would provide, then, is provide for the preparation of the teaching materials, the content, the curriculum materials. Now, when the local school board decides to use it or not is always a local decision. That is never going to be mandated by any group. But if the materials are not available, there is no way they are going to use it.

Now the judgements this committee will have to make is, is my claim, not my claim, but that of the National Science Teachers Association, saying that you better have this new curriculum material. It is in the back of my testimony, their position statement.

I am not making this up. That is a nationally aware situation that we have a gap in our curriculum materials, the glue that links the math and the physics and the computers together is how they relate to us and society.

I am saying that curriculum materials, teaching materials for that area, are lacking in the United States, they are being prepared elsewhere, we should have that material; that is a Federal responsibility, to make that kind of stuff, nationally prepared, and make it available.

Mr. Bartlett. Mr. Chairman, if I might——

Ms. Futrell. Could I respond to that, please?

Mr. Bartlett. Who would ordinarily prepare the curriculum for this subject or others?

Mr. Roy. The material prepared and written has been prepared by two national groups, a national group of university professors working with a national group of school teachers. I think that is the only way it can be done. So we need groups preparing, university faculty and school teachers working together to prepare such materials.

Ms. **Futrell.** I just wanted to respond that one of the things I really liked about what I read in the bill was the fact that we are calling for an evaluation of the current situation in the various school districts. That evaluation would be conducted by teachers and by administrators and members of the community. I think that is very positive.

We view this bill as a prelude. I would assume one of the major factors we would consider is the whole area of teacher training, those currently in the profession and those coming in, how do we upgrade that training so those teachers are prepared to do the best job possible in teaching science, math, et cetera?

I had the honor of working with the Carnegie Foundation which just completed a study of the high schools throughout the Nation. In that report they point out there is a very serious problem and that in order to address the problem we really need to look at teacher training, also the curriculum, what courses are required, the materials we are using to teach the curriculum, and how we work with the colleges and how we link the science, technology, and math together.

A lot of schools offer science and offer math, offer technology, but is there a common linkage. We do not want the money to simply be thrown into the school districts and no one really knows what is going to happen; are we going to go out and buy a lot of equipment and then not have teachers trained to use the equipment? We want to make sure the whole situation is evaluated and that wherever we go with this program, we are basing it on the need of the school district and the needs of the community at large.

Mr. **Miller.** It seems to me people perceive this is a problem at the secondary level, if you will, the 9 through 12. Is that accurate?

Ms. **Futrell.** I am a secondary teacher. I would say that it goes into the elementary schools, and permeates the local schools and up through the colleges. I would not say, let's just start there and then move forward. I would say, start at the elementary level.

Mr. **Miller.** I think that is very important, to keep our theory of education, of educating the masses. It would seem to me that we have got to keep one eye on the elementary teacher who hopefully is competent enough so that the child will be able to exercise the option when they are in high school.

One of my concerns of this problem is that we keep talking about people who are in college, people who are in high school. I suspect a lot of people made decisions about science and math because their underlying education was not sufficient where they felt comfortable proceeding to the next rung on the ladder.

Again, trying to capture the generation, it seems to me that some attention has got to be focused on those first 3 or 4 years in school, so that that generation can then take advantage of the teachers 9 through 12 who have gone through in-service, and you can kind of get a marriage there maybe 4, 5 years from now. It seems to me if you don't do that, the marriage is put off until the end of the decade and that is getting a little late.

Ms. FUTRELL. The Carnegie study pointed up the very issue you raise. We do need to go back into the elementary schools and place a major focus at the elementary level on science, math, foreign languages, technology, et cetera. I agree not only with what you are saying but with some others——

Mr. MILLER. You are saying we need aid to education.

Ms. FUTRELL. Of course.

Mr. MILLER. It would seem to me math and science will take care of itself. Not to put down this legislation, because I think it is essential. But math and science may take care of itself if we had a good system of education. People will make logical choices according to the demands of the marketplace, as the people on my right say. What we don't have is the ability of the people to exercise those options.

Ms. FUTRELL. What I am saying is that I concur with the concept that we need to start at the elementary level. NEA as an organization is not opposed to that. The Carnegie Foundation also pursued that same point, that we need to emphasize the science and the math at the elementary levels as well as the high school and college levels.

Mr. MILLER. We ought to go back to the old position, one-third, one-third, one-third.

Mr. THOMSON. May I comment about the elementary schools. Talking about competitiveness with other nations, we have to look at their school system at the elementary level. For example, in the Soviet Union, their math and science specialists are teaching at the fouth, fifth, and sixth grade level, versus in this Nation a generalist teachers, maybe a teacher with one or two courses in the background.

So when we look at the whole structure of the thing you see that our students who are interested in math and science basically start at a disadvantage clear at the elementary school level. So at some point down the track, this Nation is going to have to consider whether it will need to move science and math specialists down further in the school system than we now currently are operating.

Mr. MILLER. Anybody else?

Thank you very much. I am sure this panel has stimulated all of those who will testify after you this week. Thank you for your time and preparation.

The committee will reconvene tomorrow, at 9:30 to continue these hearings.

[Whereupon, at 1:20 p.m., the committee recessed, to reconvene at 9:30 a.m., Thursday, January 27, 1983.]

HEARINGS ON MATHEMATICS AND SCIENCE EDUCATION

Part 2

THURSDAY, JANUARY 27, 1983

House of Representatives,
Committee on Education and Labor,
Washington, D.C.

The committee met, pursuant to call, at 9:40 a.m., in room 2175, Rayburn House Office Building, Hon. Mario Biaggi, presiding.

Members present: Representatives Perkins, Biaggi, Miller, Weiss, Kildee, Kogovsek, Boucher, Erlenborn, Goodling, Roukema, Gunderson, Bartlett, and Packard.

Staff present: John F. Jennings, counsel; Nancy L. Kober, legislative specialist; Richard DiEugenio, minority senior legislative associate.

Mr. Biaggi. The meeting is called to order.

This morning, the Committee on Education and Labor is continuing hearings on H.R. 30, The Emergency Mathematics and Science Education Act.

This legislation authorizes $300 million for fiscal year 1984 and such sums as may be necessary for fiscal year 1985 for programs to upgrade mathematics and science education and to address teacher shortages in these subjects.

The bill would provide funds to local school districts for elementary and secondary programs of in-service teacher training and modernization of mathematics and science instruction.

At the postsecondary level, H.R. 30 authorizes congressional scholarships to encourage students to become mathematics and science teachers in other activities.

I feel strongly that improving mathematics and science education programs ought to be a priority of the 98th Congress. I am also glad to hear the President say that it will be a priority of the administration's this year.

Chairman Perkins will be returning shortly and in the interim, we will proceed.

Mr. Goodling.

Mr. Goodling. I have no comments at this time.

Mr. Biaggi. Mr. Weiss.

Mr. Weiss. Thank you, sir, no comments.

Mr. Biaggi. The first witness will be Hon. John J. LaFalce, a Member of Congress from the State of New York.

STATEMENT OF HON. JOHN J. LaFALCE, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW YORK

Mr. LaFalce. Thank you very much, Mr. Chairman, it is really an honor for me to be appearing before this committee today, and I want to applaud you and Chairman Perkins, Congressmen Simon and Goodling, and really all the members of the committee, for the work they have done so far on H.R. 30, the Emergency Mathematics and Science Education Act.

Rather than read from my prepared text, I would ask unanimous consent to have the entire text included in the body of the record.

Mr. Biaggi. Without objection, so ordered.

Mr. LaFalce. And then let me just speak off the cuff very briefly about 5 minutes and then you can hear the experts. I honestly believe that there is no issue more important in Congress right now than addressing the educational deficiencies in the United States, particularly in mathematics and sciences and foreign languages.

How we should do it is extremely debatable. Whether we should do it cannot be debatable. Whether we should do it immediately, and with a large program, should not be debatable.

Yesterday I was elected chairman of the Subcommittee on Economic Stabilization. I am extremely worried about the economic future of the United States of America. Last night I went to a lecture, Congressman Weiss was there, too, and the author of a best-selling book right now, Megatrends, was there, John Naisbitt. He said, it is not so much that we are in a recession or a depression, he said, we are facing a revolution within our economy. We are going from an industrial society to a service, a technological, an information age.

Now, one does not have to believe everything he has to say, but there still is tremendous truth in that statement, maybe not totally true, but there is tremendous truth there.

In my prepared statement, I would quote from a management expert, Peter Drucker, who says that within 25 years, the proportion of the American work force employed in manufacturing will decline from approximately 20 percent today to as low as 5 to 10 percent.

Now, where will those jobs go? Well, I think they are going to go into fields that will require a tremendous amount of expertise in mathematics and science.

I could go on and on with the facts. Your committee and subcommittee have probably received them ad nauseum. Yet, we have not been addressing the problem. The lowering of the SAT scores over the past decade or so, except perhaps for a minor stop this past year, some horror stories about teacher illiteracy, the brain drain that is existing, the inability to get adequate teachers, satisfactory teachers in the math and the sciences and to keep them.

We need a massive, and yet a selective program, to address this problem. As we had the National Defense Education Act of 1958, I think we should have the National Defense Education Act of 1983. As Sputnik scared us, what made us move, made us act, we ought to be frightened out of our wits today at the declining productivity rate in the United States. We ought to be frightened unbelievably by the ascendency of other countries in the international marketplace and the descendency of the United States insofar as international competition is concerned. We ought to resolve to correct that.

On my Economic Stabilization Subcommittee, I intend to do all that I can within the powers of that subcommittee. But this committee, your committee, has to address the educational components of that agenda. That is perhaps the most important component of the entire agenda.

What do we do? Well, you have got one approach here. I would caution you, although we need fast action, it does not have to be this week, it does not have to be this month. It ought to be careful action, it ought to be this year, but let's not act precipitously just for the sake of action.

Some other caveats. The President Tuesday night said, let's have block grant money going to the States. I am very wary of that. Why? Because you don't know what the States will do with the money given for math and the sciences?

We do not know that that money will supplement the existing programs; they might supplant them. Money is very fungible. And the money that was already being used for math and science could be used someplace else.

Mr. BIAGGI. Reinforce your concern, excuse me. Reinforce your concern about that. It is a valid concern to this committee, and I was a member of the committee at the time we interviewed five mayors who testified on behalf of major cities in our country when the CETA was under consideration. The members of this committee expressed the same concern.

Would they be using those funds that CETA provided to supplement or supplant? Each of them assured this committee that those funds would be used to supplement.

The fact remains, and bitter experience reveals, that each of them used those funds to supplant.

Mr. LAFALCE. Mr. Chairman, Congressmen are not expert about very many things because we must be generalists rather than specialists. I suppose if we are expert about anything, though, it might be human behavior, because one thing we are pretty good at is being politicians; we understand human behavior.

The only way we are going to make sure that a Federal program or a State program supplements, rather than supplants, is to write it into the law. It must be written into the law.

We must insure two things: That there are improvements in math and sciences: quantitatively and qualitatively within the United States. The mechanism to assure that must be in the law. If it is not, the bill does not deserve passage.

And something else. Teachers are so important and yet you get a really good teacher of math or science, and that person is going to be able to get a job outside of the teaching profession because he is going to be able to get double the money.

We are going to have to pay our math and science teachers more money than other teachers. This might bring us into conflict with unions, I do not know, maybe not. But we just cannot give money without some strings attached.

If we are going to keep our math and science teachers in the classrooms, we are going to have to pay them more and it is going to have to be more than other teachers are paid.

People are going to say, this is discrimination. My answer is, yes, that is what life is all about, discriminating, discerning. That is what we must do.

There are a whole slew of other things, but——

Mr. BIAGGI. If I may, on that point, you make the point, I think what you really intend is to provide some incentive to encourage math teachers, one, and two, to have them retained in the educational system.

Mr. LAFALCE. Correct.

Mr. BIAGGI. The method in which we do that has not been determined as yet. The proposal you suggest will produce exactly what you said it might, resistance from the labor unions, and ultimately, if we are to pursue that proposal with math and science teachers obtaining more salaries, there will be an attempt on the part of labor unions to close that gap so there will be no differentiation.

What has been suggested by others, and this is the second day of those hearings, people testified yesterday, is that we provide those math and science teachers with an opportunity to earn more money. That would be to have them work during the summer periods, as well as perhaps provide some fellowships for them. In any event, incentives should be produced.

Mr. LAFALCE. There are many approaches that can be taken. They are not mutually exclusive. We can provide incentives during this summer. We can provide additional stipends during the regular year. We can offer loans which would be forgiven based upon the length of service that one provides in the classroom.

For example, if we give a loan to study math or sciences, and an individual teaches 1 year, we could forgive one-seventh of the loan, and for 2 years, two-sevenths, it could be one-eighth or one-tenth, too, depending upon the period of time.

I think Representative McCurdy has a bill in along those lines and I am a cosponsor of it. We ought also to consider giving incentives for school boards to experiment with longer school years. We do not have to rely upon the agrarian economy that we had in the 19th century to guide us in our education system as we approach the 21st century. I think we can have a longer school year and not have an intellectual vacation for 3 months. Not that we should mandate that, but perhaps we should provide incentives for experimentation.

Mr. Chairman, that will conclude any official remarks I have to make. You have the entire text of my prepared remarks. I would be pleased to either answer questions or have you go on to the other expert panelists.

[Prepared statement of Congressman John LaFalce follows:]

PREPARED STATEMENT OF HON. JOHN J. LAFALCE, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW YORK

Mr. Chairman and members of the Committee on Education and Labor, it is a pleasure to speak before you this morning on a subject of great concern. I applaud Chairman Perkins and the Committee for your aggressive approach to the issue of deficiencies in the mathematics and science training given our young. Having developed a deep interest in this issue, I hope to share a few choice thoughts with you this morning.

The problems confronting our nation demand a national approach. Reliance on piecemeal approaches has brought us to this critical juncture; further reliance, especially in the midst of state and local government financial crisis, will guarantee a worsened educational picture. I applaud Chairman Perkins, my good friends Paul Simon and Bill Goodling, and other members for their work on H.R. 30, "The Emergency Mathematics and Science Education Act." I am a co-sponsor of that bill and hope that it receives widespread support in the House.

I wish to briefly explore two subjects in this morning. First, I will give you a few of my thoughts on the national educational problems that deserve immediate attention. Second, I will share a few thoughts on how we might address these problems legislatively.

Over the past several years, I have spent a good deal of my time on productivity-related issue. In the course of that work, it has become clear to me that the workforce of the future will be required to have different skills than our current workforce. Specifically, tomorrow's workers will need increased math, science and technical training.

Management expert Peter Drucker estimates that within 25 years, the proportion of the American workforce employed in manufacturing will decline from approximately 20 percent to as low as 5 percent or 10 percent. At the same time, however, demand for other jobs will increase. Members of the American Electronics Association estimate that by 1985 they will have new job openings for 140,000 paraprofessionals in such areas as engineering assistance and laser technicians, and for at least 110,000 professionals in such positions as engineers and computer analysts. The United States Department of Labor estimates that between 1978 and 1990, the demand for professional and technical workers will increase 19 percent—or almost 2.7 million new job openings.

The handwriting is on the wall. New jobs in our economy will not be found in the traditional manufacturing and heavy industrial sectors; the "brawn" industries will be supplanted by the "brain" industries. While I intend to actively pursue means to help our basic industries regain their economic health, we must prepare our nation for a new, highly technological age. The question that remains is the degree of our preparedness.

The work of this Committee and other interested foundations, associations, and research centers indicates that the United States has a poor, indeed weakening, foundation on which to build a technological future. The National Commission on Excellence in Education has been told a series of horror stories during its existence, ranging from declining SAT scores to teacher illiteracy. The most bizarre stories have usually received headline coverage. Buried deep in most analyses of national educational problems, after the stories about classroom violence and SAT scores, are the hard, cold facts about declining levels of training and comprehension in the maths and sciences.

A report by the National Science Foundation and Department of Education entitled "Science and Engineering Education for the 1980's and Beyond" has noted that:

After the 10th grade, only about one of three students takes chemistry and only one in seven studies physics;

One-half of all U.S. high school students take no mathematics or science beyond the 10th grade and only one-half of the students entering college have had any major exposure to math or the physical sciences beyond the 10th grade.

The American student's counterpart in the Soviet Union will face a much different education regimen. All Russian high school graduates must have 2 years of calculus, 5 years of physics, 4 years of chemistry, 5 years of biology, 1 year of astronomy, 3 years of mechanical drawing, and 10 years of workshop training.

In early 1982, the National Commission on Excellence in Education was told that:

A survey of the 50 state science supervisors in 1981 indicated that over 75% of the states are experiencing a "critical stortage" or "shortage" of physics, chemistry, and mathematics teachers at the secondary level; and

Up-to-date curricula in science appropriate for students not planning a career in science are in very short supply.

This Committee has, as a result of prior hearings, a wealth of documentary evidence to supplement these few statistics I have noted. The point that is well evidenced is the growing disparity between job-skills requirements for the balance of the 20th Century and the training our youth are receiving. The challenge before the Congress is how best to encourage the rapid improvement in training across our land.

I believe H.R. 30 is a good starting point for the Congress's work on this issue. Its broad approach, encompassing elementary, secondary, and postsecondary initiatives, is needed; for the problem crosses all levels of education and thus a solution must do likewise.

Having discussed the issue of national legislation to address this problem with education leaders from New York State and from other parts of the country, I do wish to suggest that the Committee consider an alternative to a simple formula method for distributing funds to school districts under the elementary and secondary portion of the bill. While I do not wish to burden either local or state school systems with unnecessary red tape, I believe that all, or most, of the funding ought to be contingent on the demonstrated achievement of certain established standards. If we are to provide a national program for national improvement of student training in such specific areas as the maths and sciences, we ought to require districts receiving federal funds to have programs ready and capable of using those funds to help our children learn these skills. While I favor giving local officials flexibility, I also believe that minimum standards will provide an incentive for tardy school districts to speed up their work on these programs.

In the area of elementary and secondary education, I also believe the Committee ought to examine the benefits of encouraging, through the availability of federal funds, changes in curricula and school year program to enhance the training process. In the area of curricula, I hope that one sugject that will be explored will be the availability of biology, chemistry, and physics courses at different intellectual levels. If we are to train large numbers of your youth in these programs, we must take into account different capabilities. School districts ought to be encouraged to take this progressive and practical approach. In the area of school year programs, I believe we ought to encourage experimentation in the length of the school year. Our current tradition of 9 months in school and 3 months out for an "intellectual holiday" is based on the needs of an agrarian society. School districts that wish to rearrange that outdated process and use a new program to emphasize the maths and sciences deserve to be encouraged. These are but two examples of my larger point: minimum standards, when combined with incentives for experimentation, can provide long-term benefits for our national educational needs. We will save money wasted on unorganized, hastily-conceived programs and encourage experimentation that may provide us with new answers to these challenging problems.

In the area of postsecondary education, I heartily endorse H.R. 30's provisions dealing with scholarships for college students and for teacher education programs. I have also co-sponsored Representative Dave McCurdy's bill, H.R. 6775 in the 97th Congress, which would provide loans to college students who intend to pursue careers as math, science, or related fields teachers. This bill would forgive a portion of the loan for each year the student serves as a certified teacher in the public schools. If we truly wish to encourage outstanding students to pursue these careers, the minimum we can do is help pay for their increasingly high college education bills.

To assist teachers in their efforts to keep pace with changes in classroom technology, new curricula, and other matters, I suggest that the Committee consider making funds available for inservice training during the school year as well as during the summer months. If our math and science teachers are to adapt to new trends and grow intellectually, "continuing education" can not and should not wait for the summer break. We have to break our traditional patterns of addressing these issues, for the challenge facing us is growing with each month and each year.

I thank the Committee for devoting several days to hearings on specific legislation so early in the new Congress. It is a reflection, I believe, of the seriousness of the problem and your resolve to address it as soon as possible. I hope that these few observations have been useful. Because of my interest in and work on productivity and jobs-skills issues, I have a limited expertise that I wish to offer to the Committee during its work on legislative alternatives.

In his superb book, Excellence, John Gardner noted that "we cannot have islands of excellence in a sea of slovenly indifference to standards." This is the challenge the Congress faces as it attempts to carve out national excellence as an alternative to a sea of incompetency marked by a few, remote islands of technical and intellectual excellence.

Thank you for allowing me to speak before you this morning.

Mr. BIAGGI. I want to thank you for your statement, Mr. LaFalce. It is significant in that you place a special emphasis on the needs for this approach or for an approach to resolving the problem.

Apparently we have at this moment, we have sufficient number of teachers in science and math that are qualified, but what we have, what is being revealed in testimony, is that they do not stay on because they are induced to leave because of the high technology industries paying substantially more money.

We had Mr. Fuqua, Congressman Fuqua, testified as the chairman of Science and Technology Committee and they are developing some legislation. Our committee obviously is in the forefront, but there will be no single approach, it will be a multifaceted effort to deal with the problem.

Mr. **LaFalce**. Let me just leave you with these thoughts as I depart. First of all, if we are going to improve productivity within the United States, if we are going to prepare ourselves to be a great economic power in the future in the technological age, in the information age, there is no more important thing that we can do than invest in education, but invest appropriately.

We must write into the statutes a mechanism for insuring that whatever assistance we give will improve math and science, and I think foreign languages, too, qualitatively and quantitatively.

Thank you.

Mr. **Biaggi**. Thank you, Mr. LaFalce.

Mr. Goodling.

Mr. **Goodling**. I appreciate your coming before us, Congressman LaFalce. I agree with most of what you have said. We have to insist that Federal dollars under this legislation are used to supplement and not supplant State and local efforts. The extension of contracts to provide for summer employment for math and science teachers is probably the best way to go. Then you would not have to determine that a math teacher or a science teacher is so much more important than an English teacher or a history teacher or somebody else because they are all very important. Any proposal for an actual salary differential would not be viable.

Mr. **LaFalce**. They are all very important, but we have needs in society; we have to address those needs.

Mr. **Goodling**. I think we can solve those problems with the extended contract approach. Where labor has to give in is in the area of there is no such thing as a $700 across-the-board or $1,000 across-the-board increase in pay, because there is nothing that upsets a good teacher more than to realize that the teacher working next door, who does not do much of anything, is receiving the same pay increase as the person who is knocking themselves out in the next room, trying to do an excellent job.

We are way behind, I think, in the area of rewarding excellence and that is over and above whatever the contract says in relationship to a minimum salary. So there is an area where they are going to have to give in.

Mr. **LaFalce**. I will stay out of that. I will let you handle that one.

Mr. **Goodling**. As I indicated there yesterday, there is not a shortage of people who are trained to teach math and science, there is a shortage of good math and science trained people teaching math and science. They are other places, and we have to find a way first of all to attract them; second, many of them who are qualified take jobs in industry instead. I have interviewed people and thought that I was hiring them for their very first teaching job only to find out 2 weeks later they have taken a job with industry.

So, they have been trained, and there are a lot out there who are trained. The real problem is how do we keep them and how do we reward them for being outstanding math and science teachers?

The other area that I am so much concerned about is that we spent so much time for so many years talking about secondary and postsecondary. I have got news for the world, we are never going to change the situation unless we really do it on the elementary level.

Mr. **LaFalce**. I agree. I do mention that point in my prepared remarks.

Mr. **Goodling**. Thank you again for testifying.

I just wanted to say, Mr. Chairman, that we are very happy. We reorganized yesterday and we have people who are extremely interested in elementary and secondary and vocational education that are going to be on this subcommittee. Mr. Gunderson was on our committee last year, but not on the subcommittee. Mr. Bartlett and Mr. Packard, also, will be new on this subcommittee and they are all very much interested and have had some experience and expertise.

Mr. **Biaggi**. Mr. Weiss.

Mr. **Weiss**. Thank you very much, Mr. Chairman, I, too, want to express my appreciation to our colleague for taking the time out of his very busy schedule to give us the benefit of his thinking as we are grappling with the most appropriate approaches and most feasible and the most adoptable in as quick a time as possible.

I am sure that we will be taking many of their ideas into consideration in that process.

Thank you.

Chairman **Perkins** [presiding]. Let me thank you very much this morning.

Mr. Gunderson.

Mr. **Gunderson**. Thank you, Mr. Chairman. John, I want to compliment you on your testimony. I read your transcript and was trying to listen to you at the same time and I wish I had an hour to sit down and discuss some of these things with you.

I agree with much of what you have said. Let me present the dilemma I have, and I wish I would have been there last night so that I could have heard Mr. Naisbitt.

My problem, much like yours, is that I think there is no question we have got to do it, the question is how. My concern about H.R. 30 is that we are giving money almost by population formula throughout the country and I am trying to determine——

Mr. **LaFalce**. I do not like that approach.

Mr. **Gunderson**. That is exactly what I want to ask you. How ought we do it so that we do not provide a disincentive to schools who are doing a good job right now, but also get the money where it is needed.

If you have any recommendations I would like to hear them.

Mr. **LaFalce**. I am trying to come up with some myself, although I do not have the staff backup and the expertise, I have been working with different groups.

One of the problems with working with different groups is they all have their own ax to grind, and if you work with school boards they want to make sure that the school boards are taken care of; if you work with States, they want to make sure the States are taken care of; if you work with teachers unions, they want to make that the teachers are taken care of.

All of them have legitimate points of view. There is some truth to all their perspectives, but I do not think that any of them really represent the public interest. That is what we have to do. That is what you have a special responsibility to do.

I do not think that just scattering the money out to the States, or scattering the money out via population formula is the way to do it because it does not insure what I think we have to insure that we mandate in legislation that you only receive money if you improve education in the math and sciences qualitatively and quantitatively.

Mr. GUNDERSON. OK, thank you.

Thank you, Mr. Chairman.

Chairman PERKINS. Thank you very much for your appearance here this morning.

Mr. LAFALCE. Thank you, Mr. Chairman.

Chairman PERKINS. Next we have a panel: Ms. Rayma C. Page, president, National School Boards Association, come around, Ms. Page; Dr. Robert E. Yager, president of the National Science Teachers Association, accompanied by Mr. Bill G. Aldridge, Dr. Walter S. Smith, and Ms. Jane B. Kahle, president of the National Association of Biology Teachers; and Ms. Lois Rice, senior vice president, Control Data Corp.; are you on this panel, Ms. Rice?

Ms. RICE. Yes, I am.

Chairman PERKINS. All right, come on around then, all of you. We will hear from you first, Dr. Page.

STATEMENT OF RAYMA C. PAGE, PRESIDENT, NATIONAL SCHOOL BOARDS ASSOCIATION

Ms. PAGE. Thank you very much, Mr. Chairman.

I am Rayma Page and I am president of the National School Board Association and I bring you greetings, also, from very warm Ft. Myers, Fla., where I am chairman of the Lee County School Board.

I am very appreciative and the National School Board Association [NSBA] is appreciative of the fact that both you, Chairman Perkins, and Mr. Simon, are holding these hearings, as well as that you have committed yourself to expeditious legislative action to advance the national interests of mathematics and science education. It is time, I feel, that the Federal Government plays a strong role in this.

Inasmuch as NSBA has testified last September on the full scope of the role which ought to be played by the Government, I am not going to present an indepth analysis and the paper you have before you, even though I know your names are not Johnny, I am quite sure all of you can read.

I am just going to pick out some of the highlights that I think that you might like. I am also going to give you the good news and the bad news, and I think I will start with the bad news so we can end on a lighter note.

In recommending a responsive solution, the National School Board strongly urges that a locally based, comprehensive approach be taken. The best programs will not be designed if Congress legislates a series of piecemeal programs that may or may not address the precise categorical needs of particular school systems, or whose success depends upon the packaging skills of local grant writers.

Indeed, to date, Congress has not addressed educational needs of true national significance on any piecemeal basis. For example, in serving the needs of disadvantaged and handicapped students, the Federal role, under chapter I of Public Law 94-142, does not require school districts to develop a separate, single-purpose grant for each aspect of educating those children, such as inservice training, equipment or special textbooks.

Fragmenting local program development in this way would be a mistake. Ideally, the improvement of mathematics and science should be placed on the same footing, that is, there should be one comprehensive maintenance program rather than separate grant programs for computers, for inservice training, and so forth.

It was for all of the above reasons that NSBA worked with you, Chairman Perkins, toward the development of the NEED bill, H.R. 659, and it is within the foregoing context that I would like to turn to H.R. 30.

By limiting the authorization of appropriations in H.R. 30 to $250 million for elementary and secondary education, it is clear that funding levels will not be adequate to establish a broad, local maintenance program in mathematics and science.

Any suggestion that a bill of this magnitude could underwrite local maintenance needs will only result in a Federal promise which school systems cannot deliver.

Accordingly, within the limits of a $250 million expenditure, NSBA supports the basic thrust of H.R. 30, which is to broadly finance capacity building for those resource services needed to strengthen programs such as in-service training and curriculum development, as distinguished from classroom maintenance needs, such as higher teacher salaries, new textbooks, or classroom courseware.

From the standpoint of ordering priorities, avoiding piecemeal programing and avoiding overpromises of what can be delivered, this approach represents the most responsible way, we believe, for spending the $250 million.

We believe that to eliminate the advanced funding is important. Assuming the funds are not used for maintenance purposes, it is not necessary to have the funds available at the beginning of the school year.

As the title of the bill does suggest, there is an emergency need. Therefore, it is not necessary to have advanced funding for program manager purposes. Why defer the commencement of any program for 1 year? We believe there is a need to eliminate conditional clause permitting the maintenance expenditures.

Section 604(a)(3) provides that where feasible, funds may be used to implement local plans for expanding and modernizing mathematics and science programs. Although philosophically NSBA would usually support the breadth of this permissive language, we are troubled that the bill at this point begins to offer more than it can deliver.

For example, the maintenance funding. Because the workplace is changing at a rapid pace, it is crucial that the academic foundation laid in elementary and secondary education be coordinated with the skills and/or the higher education requirement by the marketplace, community colleges, and the 4-year schools. So that we disagree with your idea of the improvement of data collection.

For example, there should be a research and data function to show the connection between mathematics and science education and the needs of business, defense, high-tech industries, emerging occupations and the participation of women and minorities.

We believe that you should eliminate State certification of local plans. The preamble of section 604(a) provides that the State must certify that local plans meet the requirements of the act. In effect, the Federal Government is establishing an active State role for certifying local programs or aspects thereof in mathematics and science, and while NSBA does not object to an active State role in curriculum development or instructional methods, we strongly object to the Federal Government fashioning a State-local relationship in those areas.

It should be pointed out that since this program deals with curriculum, per se, it differs from other Federal programs that require a State-to-local approval process.

An appropriate level of accountability can be attained if the State role is limited to the disapproval of any local plan which, one, fails to insure the Federal fiscal audit requirements will be met, or two, envisions expenditures which are inconsistent with the purposes of the Federal act. Now that is really what I consider to be the bad news.

Turning to the good news, we believe that 95 percent of the funds should be spent locally, and given the limited dollar level involved, and given that the thrust of the program is local capacity building, the bulk of the funds must be delivered to the local level.

At the same time, NSBA supports the notion of providing the States with a 5-percent setaside, thereby enabling the average State education agency to reserve up to $250,000 for those State programs like technical assistance and those programs used for that purpose.

We also believe that the local formula allocation and adequacy of funding for small districts is very important. NSBA did a survey to see if this was true. The survey supports a distribution of funds on a local formula basis, and because H.R. 30 is seeking to solve a problem of nationwide magnitude, and to do it quickly, we do not believe that project grants at the State level would be an appropriate approach.

A local formula allocation provides school districts with a high level of certainty and does not exclude those smaller districts who do not have grant-writing resources.

One question which is raised is whether the smallest of participating school districts will receive an adequate formula allocation for their capacity building needs. NSBA conducted a 22-school district survey covering Montana, Illinois, Missouri, and Nebraska.

These school systems have enrollments of 200 to 300 students and would receive about $1,000 apiece under H.R. 30. We are convinced from that survey, though, that small school districts can participate and take advantage of these funds.

We also believe that inservicing of teachers, administrators and local school board members is very important. Financing inservice programs is a main feature of H.R. 30. With respect to teachers, because subject matter and instructional methods in mathematics and science have changed dramatically over recent years, upgrading the skills of teachers currently in school systems must be a top priority item.

We can place all the hardware, software, what have you, in a classroom. But if we put it in a classroom with a teacher that does not understand how to use it, it will not do us any good.

We are pleased that H.R. 30 includes, as I said, this inservice assistance for administrators and school board members because school board members need to know what they are spending the money for and the programs that they are approving, as well as the teachers.

Again, referring to the National Science Foundation-sponsored study, it is clear that the curriculum policy decisions frequently are made without a full explanation of the facts and the value judgments that ought to be taken into account.

If school districts are to assume the encouragement to promote mathematics and science, purchase computers and other expensive equipment, and proceed in a manner which coordinates curriculum with the changing standards of universities and community colleges and the workplace, educational policymakers will need management guidance.

The cost of error in these areas is too great to ignore the necessity for such programs.

We believe the evaluation of local resources and planning is very important and that it must be emphasized that as crucial as improving the quality of mathematics and science and teachers may be, that activity is only one element that needs to be considered in the development of capacity building.

Like the need for inservicing policymakers, it is crucial that schools systems must have management resources to evaluate their programs and assets as well as to plan for change. Especially where large commitments of public resources are involved, decisions relating to the use and coordination of technology, the replacement of textbooks, and the expansion of program offerings, should be well-managed activities.

Accordingly, we are pleased to see that H.R. 30 authorizes the expenditures of these funds. As I indicated at the outset, NSBA has a compelling preference for a Federal effort which provides sufficient funding for implementing a program of comprehensive scope at the local level.

It is for this reason that we urge the committee to pursue the NEED bill, H.R. 659. However, within the framework of the $250 million activity, we believe that H.R. 30 can result in a responsible expenditure of funds.

It is essential that a bill of this limited size does not over-promise and that it focuses on first priority needs, without resulting in the diffusion of segmentation of programs at the local level.

By emphasizing capacity building, H.R. 30 moves in the proper direction. The bill will require a number of adjustments in order to be fully viable from an operative standpoint, but within the context of the 250 million measure, NSBA supports the effort that has been made.

If some of the members of the committee believe that a program of the scope suggested by H.R. 659 cannot be enacted at this time, a capacity building program like H.R. 30 can set a responsive stage for an extension to a large program at a later time.

In closing, I would like to note that just 2 days ago, we all heard our President, in his state of the Union address, declare math and science education as a foremost priority. If we heed his direction, it is clear that a bipartisan opportunity is presenting itself to act in a major way on behalf of education.

Accordingly, I urge the members of this committee to consider the national significance of this issue and join with local school boards to pursue the NEED bill as their preferred legislation.

Mr. Chairman, and members of the committee, I appreciate your attention. The fact is that you have the bill in front of you and can read it at your leisure. Thank you for the opportunity to speak to you.

[Prepared statement of Rayma Page follows:]

PREPARED STATEMENT OF RAYMA C. PAGE, PRESIDENT, NATIONAL SCHOOL BOARDS ASSOCIATION

INTRODUCTION

My name is Rayma C. Page and I am President of the National School Boards Association (NSBA). NSBA is the only major education organization representing local school board members. Throughout the nation, approximately 90,000 of these individuals, through their state organizations, are association members. They are responsible for the education of more than ninety-five percent of the nation's public school children.

Currently marking its forty-second year of service, NSBA is a federation of state school boards associations with direct local school board affiliates, constituted to strengthen local lay control of education and to work for the improvement of education. Most school board members are elected public officials. Accordingly, they are politically accountable to their constitutents for both education policy and fiscal management. As lay, unsalaried individuals, school board members are in the rather unique position of being able to judge legislative programs purely from the standpoint of public education, without consideration to their personal professional interests.

NSBA supports a major federal initiative in mathematics and science education. At our annual convention in Atlanta last spring, our Delegate Assembly adopted the following resolution:

"2.1.20 Mathematics, Foreign Language and Science Instruction.—NSBA shall take a leadership role to develop appropriate legislative and public awareness programs to meet the vital national interest to increase support, financial assistance, and other incentives to encourage individuals to pursue and continue educational careers in the fields of mathematics, foreign language, and science instruction; and NSBA shall actively seek the cooperation and support of other organizations, both public and private, in this endeavor."

A. Urge expeditious action

On behalf of the National School Boards Association, I wish to commend both Chairman Perkins and Chairman Simon for holding these hearings, as well as for committing themselves to expeditious legislative action to advance the national interest in mathematics and science education.

B. Defining scope of national interest: Consideration of H.R. 659

In as much as NSBA testified last September on the full scope of the role which ought to be played by the federal government, we will not present an in-depth analysis of those points today.

However, I would like to briefly restate several guiding principles before addressing our specific response to H.R. 30.

First, there is a very strong relationship between mathematics, science, and foreign languages and the emerging technological workplace. Business leaders, including those engaged in national defense and the growing arena of international trade, believe that the nation's economic prosperity and security will require increased job skills, which, in turn, will be dependent upon a stronger academic foundation.

Second, student participation and interest in mathematics, science, and foreign languages in declining. further, fewer people are electing to become teachers in these areas, and many existing, qualified teachers are leaving for more lucrative jobs in the private sector. Meanwhile, school systems do not have the finances to dramatically increase teacher salaries, or to purchase new technologies such as computers or new courseware, or to provide inservice personnel at levels commensurate with a true national effort.

Third, a well thought-out national effort in mathematics, science, and foreign languages should encourage school systems to utilize the personnel and educational resources of other agencies such as libraries, museums, and universities, as well as those of the business sector. These "outside" services should also include efforts by state and national government to conduct educational research, to operate exemplary and targeted programs, and to analyze market trends and educational progress.

In sum, NSBA believes that there is an overwhelming need for the federal government to assume a role which provides financial assistance and service/informational resources to local school systems.

In recommending a responsive solution, we strongly urge that a locally-based, comprehensive approach be taken. The best programs will not be designed if Congress legislates a series of piecemeal programs that may or may not address the precise categorical needs of particular school systems—or whose success depends upon the "packaging" skills of local grant writers.

Indeed, to date Congress has not addressed educational needs of true national significance on a piecemeal basis. For example, in serving the needs of disadvantaged and handicapped students, the federal role (under Chapter I and P.L. 94-142) does not require school districts to develop a separate, single purpose grant for each aspect of educating those children—such as inservice training, equipment, or special textbooks. Fragmenting local program development in this way would be a mistake. Ideally, the improvement of mathematics and science should be placed on the same footing; that is, there should be one comprehensive maintenance program rather than separate grant programs for computers, inservice training, and so on.

It was for all of the above reasons that NSBA worked with Chairman Perkins toward the development of the National Education and Economic Development Act (the NEED Bill, H.R. 659).

It is within the foregoing context that I would like to turn to H.R. 30.

C. H.R. 30: $250 million inadequate for maintenance—adequate for a nationwide capacity building program

By limiting the authorization of appropriations in H.R. 30 to $250 million for elementary and secondary education, it is clear that funding levels will not be adequate to establish a broad local maintenance program in mathematics and science. Any suggestion that a bill of this magnitude could underwrite local maintenance needs will only result in a federal promise which school systems can not deliver.

Accordingly, within the limits of a $250 million expenditure, NSBA supports the basic thrust of H.R. 30 which is to broadly finance capacity building for those resource services needed to strengthen programs (such as inservice training and curriculum development), as distinguished from classroom maintenance needs (such as higher teacher salaries, new textbooks, or classroom course-ware).

From the standpoint of ordering priorities, avoiding piece-meal programming and avoiding overpromises of what can be delivered, this approach represents the most responsible way for spending $250 million.

The next section of our testimony discusses a number of shortcomings in H.R. 30 which NSBA feels must be corrected in order to provide a viable program.

D. Suggested corrections to H.R. 30: Eliminate advance-funding; eliminate conditional clause permitting maintenance funding; improve data collection; eliminate state certification requirement for local plans

Eliminate advance funding. Presumably the advance funding provisions of the General Education Provisions Act (GEPA) would apply to H.R. 30. Although NSBA usually supports advance funding, we believe that it is unnecessary, and a mistake to do so in this program. First, assuming the funds are not used for maintenance purposes, it is not necessary to have the funds available at the beginning of the school year. Inservice programs, planning, and curriculum development—which are the main purposes of the bill—can occur at any time during the school year. Second, as the title of the bill suggests, there is an emergency need. Therefore, if it is not necessary to have advance funding for program management purposes, why defer the commencement of the program by one year?

Eliminate conditional clause permitting maintenace expenditures. Section 604(a)(3) provides that "where feasible" funds may be used to implement local plans for expanding and modernizing mathematics and science programs. Although philosophically NSBA would usually support the breadth of this permissive language, we are troubled that the bill at this point begins to offer more than it can deliver—i.e., maintenance funding. If Congress intends to support program maintenance, it should describe in greater detail the types of activities which would constitute such a program and authorize adequate funds for the task.

Improve data collection. NSBA believes very strongly that local school systems should not operate in isolation from the rest of society in the areas of mathematics and science education. Because the workplace is changing at a rapid pace, it is crucial that the academic foundation laid in elementary and secondary education be coordinated with the skills and/or the higher education required by the market place, community colleges, and four-year schools. For example, there should be a research/data function to show the connection between mathematics and science education and the needs of business, defense, high-tech industries, emerging occupations, and the participation of women and minorities. Likewise data should be collected to demonstrate trends in student participation, student achievement levels, teacher certification standards, and the supply and demand of teachers in mathematics and science.

Eliminate state certification of local plans. The preamble of Section 604(a) provides that the state must certify that local plans meet the requirements of the Act. In effect, the federal government is establishing an active state role for certifying local programs—or aspects thereof—in mathematics and science. While NSBA does not object to an active state role in curriculum development or instructional methods, we strongly object to the federal government fashioning a state/local relationship in those areas. It should be pointed out that since this program deals with curriculum per se, it differs from other federal programs that require a state to local approval process.

An appropriate level of accountability can be attained if the state role is limited to the disapproval of any local plan which (1) fails to ensure that federal fiscal audit requirements will be met, or (2) envisions expenditures which are inconsistent with the purposes of the federal act.

Having addressed our greatest areas of concern with H.R. 30, I would like to make a few positive observations about features of the bill which we believe must be retained in order to have an effective program.

E. Essential features already contained in H.R. 30: 95 percent of funds to be spent locally; local formula allocation; inservicing of teachers, administrators and school board members; development of plans to improve courses

Ninety five percent to be spent locally. Given the limited dollar level involved and given that the thrust of the program is local capacity building, the bulk of the funds must be delivered to the local level. At the same time, the states should have enough funds to stimulate statewide strategies and to offer technical assistance programs. Therefore, NSBA supports the notion of providing the states with a 5 percent set-aside, thereby enabling the average state educational agency to reserve up to $250,000 for those purposes.

Local formula allocaton/Adequacy of funding for small districts (NSBA) survey. NSBA supports a distribution of funds on a local formula basis. Because H.R. 30 is seeking to solve a problem of nation-wide magnitude, and to do so quickly, we don't believe that project grants at the state level would be an appropriate approach. A local formula allocation provides school districts with a high level of certainty and does not exclude those smaller districts who do not have grant-writing resources.

One question which is raised is whether the smallest of participating school districts will receive an adequate formula allocation for their capacity building needs. NSBA conducted a 22 school district survey covering Montana, Illinois, Missouri and Nebraska. These school systems have enrollments of 200–300 students and would receive about $1,000 apiece under H.R. 30.

From the responses which we received, 16 school districts indicated that they do not have a clearly structured and active math/science inservice program. In fact, 14 had no program at all (particularly in Montana and Illinois). Of those who were satisfied with their programs, they relied on the following activities: inviting college professors to speak, inviting textbook publishers, sending teachers to summer workshops, and teachers working with each other. Fourteen of the school districts stated that they would be interested in receiving federal funds. Of those who were able to estimate their inservice costs most felt that the job could be done with $1,800 to $2,800.

From the foregoing it would appear that school districts of 200–300 students can only operate marginal inservice programs under H.R. 30 unless (1) they supplement their federal grant with local resources, (2) combine with other school districts, or (3) participate in the 25 percent set-aside established for those purposes under subsection 603(c)(2). Where these elements present themselves, NSBA believes that even the smallest district can make productive use of these funds. Certainly, districts of over 1,000 enrollment can operate viable inservice programs as well as other activities authorized by H.R. 30.

Inservicing of teachers, administrators and local school board members. Financing inservice programs is a main feature of H.R. 30. With respect to teachers, because subject matter and instructional methods in mathematics and science have changed dramatically over recent years, upgrading the skills of teachers currently in school systems must be a top priority item.

For the most part inservice training is not a major cost and time investment on an individual teacher basis. That is, the need is not so much one of financing the cost of changing the specialty field of a few teachers, but one of upgrading and modernizing existing skills of many.

In this regard, the National Science Foundation (1979) sponsored a study of mathematics teachers for grades 7 to 12 in which they were asked to specify those areas in which they felt a need for inservice training. The following table demonstrates the kinds of assistance needed by responding math teachers.

MATHEMATICS TEACHERS EXPRESSING NEED FOR ASSISTANCE IN GRADES 7–9 AND 10–12

[In percent]

	7–9	10–12
Learning new teaching methods	40	42
Information on instructional materials	37	41
Implementing discovery/inquiry methods	27	35
Using manipulative materials	33	35
Working with small groups	38	28
Articulation across grade levels	33	33

Source: NSF SE–80–9.

We are pleased that H.R. 30 includes inservice assistance for administrators and local school board members, as well as teachers. Again, referring to the NSF sponsored study, it is clear that curriculum policy decisions frequently are made without a full explanation of the facts and value judgements that ought to be taken into account. If school districts are to assume the encouragement to promote mathematics and science, purchase computers and other expensive equipment, and proceed in a manner which coordinates curriculum with the changing standards of universities, community colleges, and the workplace, educational policy makers will need management guidance. The cost of error in these areas is too great to ignore the necessity for such programs.

Evaluation of local resources and planning. It must be emphasized that as crucial as improving the quality of mathematics and science teachers may be, that activity is only one element that needs to be considered in the development of capacity building. Like the need for inservicing policy makers, it is crucial that school systems must have management resources to evaluate their programs and assets, as well as to plan for change. Especially where large commitments of public resources are involved, decisions relating to the use and coordination of technologies, the replacement of textbooks, and the expansion of program offerings should be well managed activities. Accordingly, we are pleased to see that H.R. 30 authorizes the expenditure of funds for those purposes.

CONCLUSION

As I indicated at the outset, NSBA has a compelling preference for a federal effort which provides sufficient funding for implementing a program of comprehensive scope at the local level. It is for this reason that we urge the Committee to pursue the NEED Bill—H.R. 659.

However, within the framework of a $250 million activity, we believe that H.R. 30 can result in a responsible expenditure of funds. It is essential that a bill of this limited size does not "over promise" and that it focuses on first priority needs, without resulting in the diffusion of segmentation of programs at the local level. By emphasizing capacity building, H.R. 30 moves in the proper direction.

The bill will require a number of adjustments in order to be fully viable from an operative standpoint. But, within the context of a $250 million measure, NSBA supports the effort which has been made. If some members of the Committee believe that a program of the scope suggested by H.R. 659 can not be enacted at this time, a capacity building program like H.R. 30 can set a responsible stage for an extension to a larger program at a later time.

In closing, we note that just two days ago the President, in his State of the Union address, declared math and science education as a foremost priority. If we heed his direction, it is clear that a bipartisan opportunity is presenting itself to act in a major way on behalf of education. Accordingly, we urge members of the Committee to consider the national significance of this issue and join with local school boards to pursue the NEED bill as their preferred legislation.

On behalf of the National School Boards Association, I wish to thank the Chairmen and members of this joint hearing for the opportunity to testify.

Chairman **Perkins**. Let me thank you very much. I think that to conserve time, we will run through the panel. Our next witness, whom we would all like to welcome here is Dr. Robert E. Yager, president of the National Science Teachers Association. You may proceed, Dr. Yager, and without objection, all the prepared statements will be inserted in the record.

Go ahead, Dr. Yager.

STATEMENT OF ROBERT E. YAGER, PRESIDENT, NATIONAL SCIENCE TEACHERS ASSOCIATION, ACCOMPANIED BY BILL G. ALDRIDGE, EXECUTIVE DIRECTOR, NATIONAL SCIENCE TEACHERS ASSOCIATION; WALTER S. SMITH, ASSOCIATE PROFESSOR, UNIVERSITY OF KANSAS; JANE B. KAHLE, PRESIDENT, NATIONAL ASSOCIATION OF BIOLOGY TEACHERS; AND JOE P. MEYER, PRESIDENT-ELECT, AMERICAN ASSOCIATION OF PHYSICS TEACHERS

Dr. **Yager**. Thank you very much, Mr. Chairman, members of the committee. The National Science Teachers Association is very pleased to be invited to appear here to give views and recommendations concerning H.R. 30.

I would like to acknowledge another association and a colleague, Mr. Joe Meyer, from Oak Park-River Forest, Illinois, the president-elect of the American Association of Physics Teachers, and of course, as indicated, Dr. Jane Kahle is here representing the National Association of Biology Teachers. We are very pleased that we are in touch with these organizations and they have agreed, have seen copies of our written testimony, and are here to support it as well.

Chairman **Perkins**. Without objection, all of those statements will be inserted in the record. Go on.

Dr. **Yager**. Thank you, Mr. Chairman. I would call to attention a few additional points and emphasize some from our written statement.

We feel very strongly that the committee should consider foremost the gravity of the mismatch as far as school science and mathematics, the curriculum and the kinds of instruction that is going on, because we feel that there is that mismatch for as many as 95 percent of the students that are enrolled in the schools across the Nation.

So although there is much data and we have been a part of collecting it as far as the scarcity of teachers, as far as the problems of equipment and other things, we certainly place as the highest priority this business of quality and how, indeed, we can produce science and mathematics programs that are more important for all people.

Mr. **Goodling**. Could I interrupt just to ask you to explain what you mean, "mismatch of students"?

Dr. **Yager**. Certainly; the feeling that the existing programs, especially in the secondary schools, were prepared primarily for college preparation, that the students enrolled are there so that they can go to 4-year colleges generally with the idea that they will become practicing scientists and engineers.

I think that our position is that this is such an important issue that we owe it to all students enrolled in K through 12 settings to have a science that is appropriate for them, science for citizenship, as it were, and that much of our efforts during the 1960's were directed toward preparing materials to produce more scientists and engineers more quickly.

So we are saying that many of these courses and programs are very fine, but unfortunately, they seem to be appropriate for but a few.

We are very concerned with some of the information that was reported in the third assessment of science of the National Assessment of Education Progress, which shows across-the-board, that the longer the student stays in school, the less enchanted he or she is with the kinds of science experiences that are there.

We feel that these data have not received a lot of attention and, indeed, this is the kind of thing that should affect our thinking about programs and teaching within the schools.

We feel that the data would suggest that 90 percent of the high school graduates are released to life essentially with less interest than they had when they started in the elementary school with no more knowledge, in other words, knowledge does not increase across time, and that they do not seem to have the ability to pursue the interest that is there or the knowledge that they have attained.

These kinds of studies are very important and should affect our thinking in terms of support and new direction in the field.

We see in H.R. 30 dollars to alter science programs in local education units and we think that this is fine, but we raise the question, how? What does it mean? Where are the criteria?

We see dollars suggested to increase supplies and equipment. But we wonder if this means that what will be done is to continue to do what is being done now, which in many respects seems inappropriate.

We see dollars for inservice education for teachers, administrators and board members and we say that this is good, but we ask, what kind of in-service, who will be providing it and what will be the goals?

We see a problem with the $250 million being proposed for use in ways not specified. We see the Part B of the H.R. 30 suggesting an emphasis upon research, development, establishment of new criteria, institutes and training for teachers, as well as the improvement of college programs.

We see that these are very important elements in terms of setting and correcting this mismatch that we have talked about, and we suggest that there may be a difference of opinion in terms of relative importance of the two parts of the bill.

We think that it is important to have qualified teachers, but we ask the question, what makes a qualified teacher? Many of our studies now show that effective teachers do not result simply from more content preparation. There are problems with the kind of sciences and the kinds of mathematics that teachers do receive as a part of their training already.

We think that it is important that teachers have an inquiring mind and that they are searching for more understanding and searching for some of the very features that are basic to science itself.

I would conclude with just seven overall comments that we have, and again, many of these are elaborated on in the written testimony. We question the merits of $250 million in part A of the bill and only $50 million for part B.

No. 2, we question who determines the merits of the SEA and LEA plans. We question what is to be the focus for curriculum and instructional improvement. We question who is reviewing the current state of knowledge concerning programs and approaches.

We favor national curriculum models, but we favor LEA choice and adaptation. We feel that many options should be available.

No. 6, we favor applying the knowledge that has been amassed about learning and teaching, and there has been much that has been amassed just in the last 5, or at most, 10 years.

And last, we urge caution regarding allocations to States and entitlements with the assumption that improvements will result.

Again, we thank you very much for the invitation to appear and we certainly welcome the opportunity to interact with questions.

Thank you.

[Prepared statement of Dr. Robert Yager follows:]

PREPARED STATEMENT OF ROBERT E. YAGER, PRESIDENT, NATIONAL SCIENCE TEACHERS ASSOCIATION

INTRODUCTION

It hardly seems necessary to document the pre-college science and mathematics education crisis which is addressed by H.R. 30. As the primary source of data on the crisis, the National Science Teachers Association has been deluged with requests for detailed information and suggestions for solutions.

The data have been collected by NSTA through three different surveys conducted over the past two years. As a consequence of this activity, and through discussions among leading science education experts, the crisis in elementary and secondary school science and mathematics education can be summarized as follows:

1. There is a shortage of qualified secondary school science and mathematics teachers. The shortage is critical in mathematics and physics;

2. There is a serious mismatch between existing secondary school science and mathematics curricula and the needs and interests of the vast majority of students;

3. There have been few attempts to alter instruction in schools in ways consistent with the growing body of new knowledge about learning/teaching science.

4. Supplies, equipment, and other resource materials are severely limited or obsolete in most science classrooms and laboratories; those that exist are more appropriate to science curricula and teaching strategies of a previous time.

5. Science is nearly nonexistent in elementary schools. Teachers are ill-prepared, resources are lacking, and the focus is on the so-called "basics" which has tended to ignore science.

The shortage of science and mathematics teachers

The shortage of science and mathematics teachers is documented by looking at supply and demand. The fall 1981 NSTA survey of 600 colleges and universities that prepare science and mathematics teachers showed a shocking ten-year decline: a 79 percent decline for mathematics and a 64 percent decline for science. (See attached paper by Shymansky and Aldridge.) Data from the fall 1982 survey show a further decline. (See attached graph.)

The demand for science and mathematics teachers has been documented by Howe and Gerlovich at Iowa State in surveys of state science supervisors. NSTA derived demand data from surveys of secondary school principals. Our fall 1982 survey showed that secondary schools employed 6 percent more science and mathematics teachers in 1982-1983 than in the previous year. With widespread calls for increased requirements for science and mathematics in high school, we can expect further increases in the demand.

Now, if the supply has dropped so drastically, how can the schools be finding teachers to fill classes? They have been employing underqualified teachers. Hiring such teachers is made possible through provisional or emergency certification, or through extremely low certification standards. The emergency measures have made possible the reassignment of teachers from physical education, home economics, social science, elementary education, and other fields where surpluses exist. A more common problem is transferring teachers within science, that is, from biology to chemistry and physics, without sufficient qualifications in those subjects.

When promising but underqualified teachers are taken from the elementary school and reassigned to secondary schools, the situation is doubly tragic. The secondary school science or mathematics students are instructed by an unqualified teacher while the elementary school students lose a teacher with promise in mathematics or science. The situation at the elementary school level is especially serious, and we need teachers at that level with interest in and some knowledge of science or mathematics.

Committee members may be aware of an example in Montgomery County, Maryland, one of the wealthiest school districts in the nation. (See THE WASHINGTON POST, January 16, 1983, page B8.) Their solution to the shortage of mathematics teachers at the secondary level was to offer a quick workshop dealing with basic mathematics for interested elementary school teachers. Then these teachers, so badly needed at the elementary level, would be placed in secondary school mathematics classrooms, where they would be clearly underqualified. This is a wealthy school district! One can only lament what must be happening to students in poorer districts in this country.

Principals are faced with an overall declining secondary school enrollment, a surplus of teachers in some areas, and a shortage of science and mathematics teachers. Who can blame a principal who reassigns a long-time faculty member from a nonscience field into a science or math slot when no qualified teacher can be found? Moreover, even if a qualified person were available, tight budgets and teachers' contracts may preclude a principal from hiring a new staff member; thus the principal is forced to meet the need through staff reassignment.

The demand for science and mathematics teachers is even greater than indicated by open positions. According to NSTA's fall 1982 survey results, for lack of teachers and/or resources, some 32,000 classes in science and mathematics which were needed, could not be scheduled in 1982-1983. Instead, some 640,000 children who wanted to take science or mathematics were required instead to take courses in *other* subjects for which no teacher shortage existed.

The outdated curriculum

The lack of sufficient numbers of trained teachers is compounded by the mismatch between science and mathematics curricula and the needs and interests of students.

The science and mathematics curricula in U.S. schools today are, for the most part, only slightly modified versions of the spectacular curricula developed after Sputnik by teams of scientists and teachers. Yet, as Jerrold Zacharias, MIT physicist, and originator and developer of one of the first National Science Foundation curriculum projects, PSSC Physics, said,

"We had aimed only at the college-bound and college students because we could not do everything at once" (in testimony before the Subcommittee on Science, Research, and Technology of the Science and Technology Committee on February 19, 1980).

These curricula neglect the needs and interests of the vast majority of students. They focus on pure science and are largely devoid of practical applications, technology, or the relevancy of science to society's problems such as acid rain, nuclear wastes and disposal, improper nutrition and so forth. They do not prepare people to enter the myriad or non-science occupations which require technological knowledge for which science is the base for real understanding. Nor do these curricula properly take into account the utilization of the computer and modern electronics. Technically well-trained people are needed by emerging or rebuilding industries to solve the economic problems we face.

The curricula in most schools are curricula of the 60's and they are obsolete!

New institutional strategies

The last ten years have provided much new information concerning the way humans learn. The current literature suggests exciting new information concerning the adolescent mind, how it grows and develops. Information from studies in cognitive psychology need to be applied in school science classrooms.

Further, new views of the nature of science and the many dimensions that can be studied are being reported. These studies suggest new approaches to instruction, new ways for science teachers to approach their tasks.

Use of the current research is needed as teachers are retrained, and all too few new teachers complete preparatory programs to gain certification.

Abbreviated description of H.R. 30

The bill introduced by Mr. Perkins would address several aspects of the present crisis. That bill can be breifly summarized as follows:

H.R. 30 amends the NEDA of 1958 to authorize up to 250 million dollars for mathematics and science education in elementary and secondary schools and up to 50 million dollars for post-secondary institutions in fiscal year 1984. No money may be appropriated if Block Grants are not funded at or above the previous year's level.

Part A (elementary and secondary)—All money for this part will go to State Education Agencies (SEA's) with 5 percent retained by the SEA and the remainder going to Local Education Agencies (LEA's). (75 percent of the LEA's money will be allocated on a per capita basis of 5–17 year-olds; the remaining 25 percent of the LEA's money will be distributed on the basis of some equilization formula.)

LEA's may use money for:

(a) Inservice education for teachers, administrators, and board members.

(b) Evaluation of local resources for mathematics/science education.

(c) Developmemt of course improvement plans and, where possible, implementation of these plans.

(d) Development of curriculum materials.

(e) Involvement of community resources in mathematics/science teaching.

Two or more LEA's may combine forces.

Private school children will share equally (per capita) in the benefit of funds.

Part B (post secondary)—This money will be administered at the national level.

Money for Part B will be used for:

(a) Scholarships for potential mathematics/science teachers. This money is really a loan, since it must be repaid if a person does not teach for five years.

(b) Course improvement in colleges. Ten percent of Part B money will be thus spent.

(c) Course improvement in community colleges. Twenty-five percent of Part B money will be thus spent.

(d) Summer institutes for inservice teachers and supervisors.

(e) Research in mathematics/science education to be conducted by NIE. Up to 10 million dollars will be authorized for this purpose.

(f) Lab equipment purchases. All money for Part B (50 million dollars) could be used for this purpose. Cost sharing would be required (up to 33 percent federal with the remainder to be matched).

The Education Department will study the need for lab equipment and report by 9/30/84.

H.R. 30 also extends the General Education Provisions Act of 1980 (regarding minority institutes science improvement) through fiscal year 1985.

Analysis of H.R. 30

In examining the bill, the NSTA has several questions or concerns:

1. Funds under this Act cannot be spent if Block Grants are not continued at current levels or higher, but there is no similar provision which precludes LEA's and SEA's from reducing their own funding for mathematics/science education (page 2, lines 10–12).

2. Funds will automatically pass to states and through them to LEA's with no competition on the basis of the merit of plans to spend the money (pages 3–4). Such formula and entitlement programs are notoriously inefficient and ineffective. What criteria will be used in making awards?

3. An average LEA will receive $14,000 if all 250 million dollars are appropriated. Thus, funds are diluted. (Formula on page 3; amount on page 11.) What can reasonably be accomplished with such a small amount? What are the intended improvements?

4. The purposes of inservice education for administrators and board members is not specified as it is for teachers (page 4, lines 14ff). How will this inservice education improve science and mathematics education?

5. How much money can be spent for the implementation of curriculum change, and how may this money be spent (e.g., on equipment, books, or salaries)? (page 4, lines 18–21.)

6. Even though two or more LEA's may combine funds (page 5, lines 6–9), very likely each district will have to invent its own curriculum materials, if they choose to use money in this way (page 4, lines 22ff and page 5). There is enormous inefficiency in having every LEA re-invent the wheel by creating new curricula. Some aspects of the models tried during the 60's are worth reviewing and trying anew. A variety of curriculum models can be produced in a national project, with modification for local needs. It is especially important that curriculum development be a joint effort between a national group and publishers.

7. The scholarships for potential mathematics/science teachers are really loans (pages 7–8) and must be repaid if the recipient does not teach for five years. There is no provision for partial forgiveness of the scholarship (i.e., loan).

8. There appears to be a conflict on who can use money to purchase equipment. The findings on page 10, lines 22ff, indicate money should be used as part of federal research proposals, but the allowable activities on page 11, lines 1ff seem to indicate that funds are more generally available. Are funds for laboratory equipment intended primarily to support teaching, research, or both? If the intention is to support both teaching and research, then what balance should be struck between funding for the two activities? How will the equipment be related to improved plans for curriculum and instruction?

9. Cost sharing (⅓ federal; ⅔ matching) will be hard on poorer postsecondary institutions (page 11, lines 1–3). Such cost sharing fails to take into account differential wealth of these institutions. It helps to make the wealthier even more wealthy at the expense of the poorer institutions and their students.

10. Although efforts to support and improve science instruction in community colleges is appropriate, is the wide difference in level of support between four and two-year institutions appropriate? What is the logic for the suggested levels?

11. The National Science Teachers Association is very concerned about some components of H.R. 30 being lodged at the Department of Education rather than at the National Science Foundation (NSF).

12. The National Science Teachers Association is also concerned with solving all aspects of the crisis rather than merely assuming that major expenditures will result in improvement. Will existing knowledge be used in setting criteria and new directions?

Excellent features of H.R. 30

If the concerns expressed in items 1–9 can be resolved, certain features of H.R. 30 are excellent, and NSTA would encourage their enactment. The specific items which we favor are as follows:

604. (a), (1)(A), (2), (3), and (5). Under these provisions, LEA's could provide inservice training for mathematics and science teachers, evaluate their mathematics and science programs, and work with the private sector.

604. (b). this would enable LEA's to cooperate in jointly funded efforts.

605. (a) (all). This component could be of great value to state science and mathematics supervisors. They have given much assistance to teachers and they have helped gather and disseminate science education information. They need support for these kinds of activities.

621. (all). This component of the Bill is excellent in several respects. It not only provides scholarships for young people who would become science and mathematics teachers at the pre-college level, but it also provides a very high level of prestige. The image of mathematics and science teaching is low, and the Congressional scholar concept and method of selection will greatly improve that image.

Why certain elements of H.R. 30 should be lodged at NSF

The National Science Teachers Association is just as important as you in the House of Representatives are with National Science Board policies and the resultant lack of science education initiatives at NSF. Yet we retain the strong conviction that science and mathematics education programs that are to be administered at the federal level must be lodged at NSF.

Jerrold Zacharias, in his testimony of February 19, 1980, stated the problem at NSF well:

". . . the Education Directorate [at NSF] is struggling against an almost impossible enemy—an emeny from within. From its inception the Science Board [NSB] that supervises the NSF has treated the Education Directorate as a trivial country cousin. They have said that the government should give the NSF money for scientific research and never mind what happens to the two hundred million people who don't do research. It is those very people whose lives, jobs, leisure, entertainment, food, security, and everything else depend on a sound economy in a democratic society. The Federal Government can no longer allow itself to neglect the schools, and the NSF has in its charter the responsibility and authority to do something about them."

That responsibility and authority is described in Public Law 507-81st Congress (64 STAT. 149, S. 147), Section 3.(2):

"The Foundation is authorized and directed—(1) to initiate and support . . . science education programs at all levels . . ."

In spite of lack of action on the part of the National Science Board in carrying out this statutory obligation, we in science education continue to believe firmly that the original reasons for lodging science education programs at NSF are still valid and important: We must develop science and mathematics education materials and train our teachers in a partnership with those scientists who create the knowledge. That knowledge, and the methods used by scientists to acquire new knowledge, are constantly changing. Science and mathematics teachers need direct, cooperative relationships with scientists and mathematicians, and involvement of research scientists in science education is essential for many reasons.

Even though the National Science Board has been slow to respond to the present crisis, as indicated by the lack of NSF initiatives scientists at universities and in the private sector as well as those at the AAAS and the National Academy of Sciences, have shown great interest and concern. Many of these persons are actively working to improve the situation.

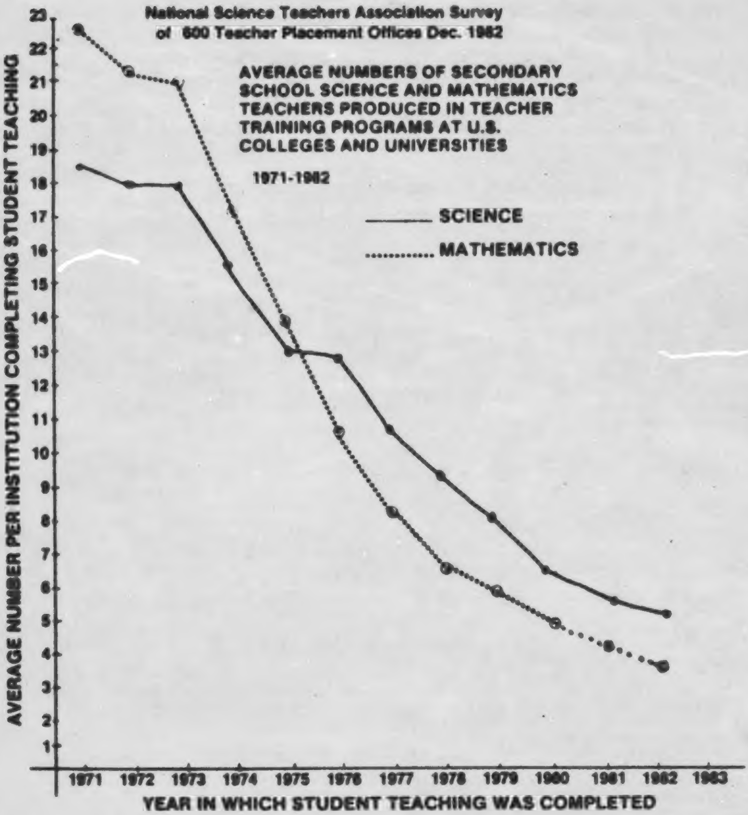
Apart from the fact that NSF already has authorization to carry out certain elements of H.R. 30, there are other compelling reasons why such programs should not be administered at the Department of Education and should, instead, be placed at NSF. The NSF is a small independent agency with a reputation for administering programs of very high quality and selected on merit, with a minimum of political interference. The Department of Education is well-known as an enormous bureaucracy, where awards are more often granted as allocations or entitlements, and where political factors play far too great a role in funding decisions. It is especially distressing that the present Administration has permitted the advisory and management components of the Department of Education to become politicized, and not just with members of their own party, or with conservatives, which would be understandable. But allowing the agency to become politicized with ideologues of the far right who often lack even the most basic education or experience relevant to the job requirements is very destructive of fair, proper, and efficient administration of government programs.

The NSF has, for the most part, been able to retain its status as an independent agency. Also, the scientific community would never permit NSF to be politicized like the Department of Education.

For the several reasons already given, the NSTA would strongly recommend that those components of H.R. 30 including summer institutes, research and development in science and mathematics education, and in science laboratory improvements, be deleted from the Bill. We would hope that the Chairman would exert his considerable influence, and, if necessary, testify before the Science and Technology Committee, to insure that these components are placed into the NSF science education program where they belong, and at higher levels than currently recommended in part B of H.R. 30.

The NSF ahs the staff, the organization, and the experience in each of these areas. Even with the severe reductions of staff in science education, many remain who were associated with development, course improvement, teacher education, and public understanding of science. The NSF has offered important programs through TV (3-2-1 Contact, NOVA, etc.), science museums, and other media to inform and educate both youth and adults in science education.

The H.R. 30 Bill has a number of excellent features, and those should be enacted and implemented. The other elements of theBill, which belong at NSF where they can be properly administered, are also excellent initiatives—though suggested funding for many of these is at a level too low for meeting the real needs (part B of H.R. 30). Under directives by the Congress, the NSF would accept their responsibilities for the programs covered under their organic act. We urge the committee to assist all of us in securing such directives by your colleagues on the Science, Research, and Technology Subcommittee of the Committee on Science and Technology.


National Science Teachers Association Survey
of 600 Teacher Placement Offices Dec. 1982
AVERAGE NUMBERS OF SECONDARY SCHOOL SCIENCE AND MATHEMATICS TEACHERS PRODUCED IN TEACHER TRAINING PROGRAMS AT U.S. COLLEGES AND UNIVERSITIES
1971-1982
SCIENCE
MATHEMATICS
AVERAGE NUMBER PER INSTITUTION COMPLETING STUDENT TEACHING
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
YEAR IN WHICH STUDENT TEACHING WAS COMPLETED

The Teacher Crisis in Secondary School Science and Mathematics

Science and mathematics instruction is deteriorating as fewer teachers pursue careers in these fields.

JAMES A. SHYMANSKY AND BILL G. ALDRIDGE

Our nation faces unprecedented problems in science and engineering education, the most severe of which is the critical shortage of qualified science and mathematics teachers at the secondary level. The problem is not new. Studies by the National Education Association (1981), Howe and Gerlovich (1982), and Akin (1980) have carried this message for several years. Yet school goes on. Is the problem not as severe as the data suggest, or worse than we realize?

We recently conducted surveys of secondary school science and math teachers, secondary school administrators, and placement directors at colleges and universities to get another reading on the science and math supply and demand. The results of our surveys and the highlights from some previous studies are reported here.

The Demand

In 1980 and again in 1981, Howe and Gerlovich (1982) surveyed the 50 state science supervisors to assess supply and demand for secondary school science and math teachers. Using a scale of 1 (a surplus) to 5 (a critical shortage), they found a shortage of physics (4.15), math (3.71), and chemistry (3.96) teachers in 1980. Shortages in physics and math became more severe in 1981 (physics, 4.45; math, 4.28). Moreover, the shortages are nationwide. Only two state supervisors reported an adequate supply of math teachers; four reported an adequate supply of science teachers; six reported an adequate supply of chemistry teachers.

Akin's (1980) findings are consistent with the Howe/Gerlovich report. In a survey of teacher placement directors in 1981, Akin reported math and physics as the highest and second highest areas of teacher demand. Chemistry teacher demand was 7th and earth science 11th of the 38 areas ranked. The NEA report (1981) also ranked mathematics and natural and physical sciences as areas where the supply of teachers is least adequate.

The data from these sources are convincing but not compelling because, after all, science and math continue to be taught. In order to provide further insight into the problem, we conducted three surveys in December 1981. Our results are quite revealing.

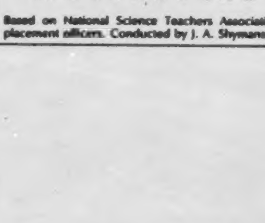
The Supply

We surveyed 450 teacher placement offices nationwide to obtain ten-year data on the number of teachers receiving certification in a science or math area and the number accepting teaching positions. Figures 1 and 2 show the number of persons available for placement and the number accepting teaching positions in math and science from 1971 to 1980. Clearly these graphs show the serious decline in the numbers of persons pursuing teaching degrees (79 percent decline in math and a 64 percent decline in science) and an equally serious decline in rate at which those prepared accept teaching jobs. The 1981 NEA report indicates a comparable decline in persons accepting teaching positions to persons prepared as teachers across all teaching fields between 1962 and 1979.

Who Is Teaching?

We also surveyed 1,000 secondary school administrators to find out who teaches science and math at their

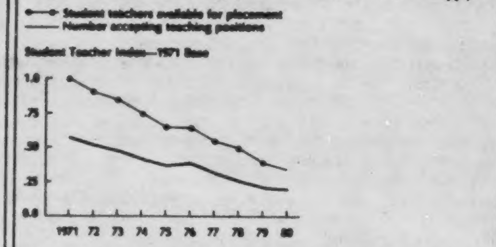
Figure 1. Student Teacher Supply Index: Math—Based on 1971 Supply.



Based on National Science Teachers Association survey of college and university placement officers. Conducted by J. A. Shymansky, The University of Iowa, 1982.

James A. Shymansky is Professor of Science Education, The University of Iowa, Iowa City; and Bill G. Aldridge is Executive Director of the National Science Teachers Association, Washington, D.C.

Figure 2. Student Teacher Supply Index: Science Based on 1971 Supply.



Based on National Science Teachers Association survey of college and university placement officers. Conducted by J. A. Shymansky, The University of Iowa, 1982.

schools, how many were retiring, how many were leaving for other jobs, and how many were hired recently. Administrators reported that 91 percent of their science and math teachers were teaching those classes exclusively in 1981–82—a drop from 93 percent in 1980–81. They also reported about a 1 percent rate of retirement in the science and math teaching staff and a 4 percent exodus to nonteaching jobs. Taken alone, these figures are not earthshaking. But data on replacements for the retirees and the job-jumpers are shocking. Nationwide, *half* of all newly-employed science and math teachers for the school year 1981–82 were unqualified to teach science or math. These teachers were reported hired on an "en .rgency basis." Figure 3 shows, by region, the percentages of emergency science and math teachers hired for the 1981–82 school year; the numbers are staggering but not surprising when viewed in terms of Figures 1 and 2. There simply aren't enough new teachers to replace those leaving or retiring.

What the Teachers Report

More than 450 teachers responded to a third questionnaire aimed at finding out about their preparation, their assignments, and their plans. From the survey we know that 60 percent of the science teachers report cuts in their budgets for supplies and equipment. These cuts are occurring at a time when school labs are already obsolete and teacher morale is low. We also learned that 79 percent of these teachers have not completed a ten-hour course or workshop in over ten years; 69 percent have never attended a computer workshop. Finally, 40 percent reported never attending an inservice course or workshop since they began teaching—an average of 16 years!

When asked about their plans for the next five years, a startling 24 percent indicated they plan to seek employment outside of education. Assuming only 4 percent actually leave the classroom for nonteaching jobs (as the administrator data suggests) and assuming the graphs showing the new entries into science and math teaching level out, the forecast for secondary school science and math is still gloomy. The mean age of the science and math teaching population is 41. As that mean moves up so will the number of retirees and the number of teaching vacancies. Demographic studies predict a leveling off of school-age populations and even a slight increase in the 80s. When these data are mixed together, it is clear that the number of emergency teachers will go up also—and that the quality of math and science instruction will go down.

Summary

Recent independent surveys all show a severe shortage of qualified secondary school science and math teachers. There has been a catastrophic decline in the number of persons preparing to teach science and math and, of those prepared, less than half take teaching positions. Secondary schools are forced to hire unqualified persons. In addition, as the mean age of the science/math teaching force rises and more experienced teachers seek employment in nonteaching jobs, the quality of instruction in our secondary school science and math classrooms will deteriorate further. We cannot afford to wait for the normal laws of supply and demand to correct the problems. A generation of school-aged children is far too precious a commodity. EL

References

National Education Association. *Teacher Supply and Demand in Public Schools, 1980–81.* W. S. Graybeal, Project Director. Washington, D.C.: June 1981.

Howe, T. G., and Gerlovich, J. A. "Critical Issues Dealing with the Supply and Demand of Science and Mathematics Teachers." Presented to the National Science Teachers Association Meeting, Chicago, April 3, 1982.

Akin, J. N. "Teacher Supply and Demand: A Recent Survey," Association for School, College, and University Staffing, Box 4411, Madison, Wis., 1980.

Figure 3. Percentage of Emergency Science and Math Teachers Hired in 1981–82.

Census Region	Percentage of Emergency Teachers Hired
Pacific States	84%
Mountain States	23%
West North Central States	43%
West South Central States	63%
East North Central States	46%
East South Central States	40%
North East States	9%
Atlantic States	43%
South Atlantic States	50%
Nationwide	50%

ROBERT E. YAGER

Robert Yager was prepared as a high schol teacher of science—graduating from the University of Northern Iowa in 1950 with a biology major and a teaching certificate. He taught science in grades 7-12 before entering graduate school at the University of Iowa. He earned an M.S. (1953) and a Ph.D. (1957) in plant physiology/biochemistry. After earning the doctorate, Dr. Yager decided against a life as a researcher in physiology and opted for a career in science education while retaining close ties with the active research team in physiology at the University of Iowa.

Dr. Yager created one of the largest and most productive science education centers in the U.S. He has advised nearly 100 Ph.D candidates, authored over 200 research reports, directed over 100 NSF, OE, and various foundation research, development, and training projects. He has been active professionally having served on numerous boards, commissions, and panels; he has been the president of the Iowa Academy of Science, the School Science and Mathematics Association, the National Association of Biology Teachers, the Association for the Education of Teachers in Science, and the National Association for Research in Science Teaching. Currently he serves as the President of the National Science Teachers Association, the world's largest science education society with over 40,000 members and subscribers.

Chairman PERKINS. Let me thank you for an excellent, concise statement, too, Dr. Yager.

Ms. Lois Rice, please proceed. Is Ms. Rice here this morning? Come on around, and the rest of the panel, we will postpone our questions until a little later. There will be plenty of questions, but we want to hear all the panel first.

If you will proceed, Ms. Rice, in any manner you prefer.

STATEMENT OF LOIS RICE, SENIOR VICE PRESIDENT FOR GOVERNMENT AFFAIRS, CONTROL DATA CORP.

Ms. RICE. Thank you, Mr. Chairman.

Mr. Chairman, members of the committee, my name is Lois D. Rice and I am a senior vice president with the Control Data Corp. For nearly 20 years, Control Data, a worldwide computer and financial services firm, has been the leader in developing computer-based education and training programs.

It is indeed a pleasure to return to this committee now in a different role, and to have an opportunity to discuss your commendable initiative, H.R. 30, the Emergency Math and Education Act. The severe shortages of qualified math and science teachers in our Nation's schools and the growing math and scientific illiteracy among our students have grave implications for our society, for our national security, and for our already eroding competitive position in world markets.

You have heard all the statistics underpinning these conclusions, so instead of dwelling on problems, I would like to dwell upon the experiences of my own company in addressing educational deficits and suggest some proved solutions that you may wish to reflect in H.R. 30.

Solutions that involve fundamental changes in the relationship between education and business and an increasing use of technology to expand our teaching capacity. At Control Data, we believe that education is everybody's business and everybody's responsibility.

Hence, there must be a much closer working relationship between corporations, schools, government, and other sectors, so that in cooperative ways, the improvements needed in education are viewed by all concerned as profitable business opportunities. Business would benefit, education and society would benefit.

Control Data, in cooperation with academia, government and other sectors, already addresses educational and other societal needs as profitmaking opportunities. We have committed major resources to the strategy, more than three-quarters of a billion dollars to the development of high-quality educational offerings.

Some school systems are beginning to adopt similar strategies to form links with industry that are indeed, and in fact, businesslike partnerships. Only the product is an educated, employable human being, rather than a commercial good.

One notable example exists right here in the District of Columbia. Control Data has entered into a partnership with the D.C. public school system to utilize technology, namely our computer-based education system called PLATO, to improve the reading and mathematical skills of 400 students at Spingarn High School. Spingarn was very carefully chosen as the site for this partnership because it is a school that trains both in-school and traditional high school students, but it also has a program after school for the District's high school dropouts.

If I am not mistaken, the school is open from about 8 a.m. until 10 p.m. at night. And that kind of environment, that length of the school day, permits the maximal use of technology and the most efficient use of it.

Both the school system and Control Data matched their investment, about $200,000 each. William Norris, our chairman, founder and CEO of Control Data, said at the outset of this important partnership, and I quote, "The program gives Control Data valuable experience in a growing market and helps reduce our costs of hiring, training, and developing our own personnel."

At the same time, Superintendent McKenzie said:

> This partnership is based on a negotiated quid pro quo. We couple business interests with educational interests in ways that are beneficial to shareholders of both companies and school.

She went on to say,

> These arrangements put our heels to the fire so that we must be accountable in business terms for hard and timely products, namely better trained students.

From its inception, PLATO has been a partnership—initially between the National Science Foundation, the University of Illinois, and Control Data—and subsequently a partnership among over 40 universities, hundreds of courseware developers, secondary schools, foundations, and big and little companies and individuals.

Through these cooperative efforts, we have developed over 8,000 hours of high-quality courseware.

PLATO began with a specially designed terminal linked to a large central computer, but PLATO offerings are now also available on our own microcomputer—the Control Data 110—and we are beginning to adapt PLATO courseware to other microcomputers, such as Texas Instruments, Atari, and Apple.

PLATO is an individualized approach to learning, allowing students to master subjects and learn problem-solving techniques and at their own pace.

Studies show that this system has indeed worked, and especially in the teaching of math and science. According to Francis Fisher, Henry Luce professor at Haverford College, in the study that he conducted and others, one group of college students used PLATO as part of the physics curriculum, another group used only conventional approaches.

Students in the PLATO group scored significantly better on a common test, and 86 percent said they would prefer their next physics course to include PLATO.

The Office of Technology Assessment, in a recent report to this committee, and to the Committee on Science and Technology, summarized studies of PLATO to date, and reported that most regard PLATO learning as being exceptional; believe that its full potential is still unrealized.

Before going into the various sections of the bill, Mr. Chairman, and making some suggestions there, I would like to just mention briefly a few PLATO programs that have proven particularly successful in the training of students in math and science.

First is our basic skills program, it begins at the elementary level in the fourth grade and continues through high school equivalency. The curriculum requires a minimum amount of instructor involvement, hence it offers both schools and colleges an economical and effective means for students to gain competency in basic skills.

And by competency, I do not mean minimal competency, but instead, the skills required to begin to master more advanced math and science programs, as well as other curricula.

Among elementary and secondary students with only average motivation and low to average ability, PLATO has been able to move many students up one full grade level in math in just 20 to 30 hours, compared with the 150 hours of traditional instruction that is required to receive the same result.

These PLATO results were with students mostly in inner cities who had, in many instances, previously failed in traditional classroom settings.

Second, to address the faculty and financial squeezes in engineering schools, Control Data is participating in a consortium of universities to develop a PLATO lower division engineering program. Members of the consortium include the engineering schools of the Universities of Minnesota, Nebraska, Delaware, Arizona, Cal State, and Florida State.

A complete freshman and sophomore curriculum is being developed, consisting of math, chemistry, physics, and computer science, plus additional humanities, English, and writing courses. About 64 credit hours in all.

The first courses in the series are now in place for the 1982-83 academic year, and the full curriculum should be available during the 1984-85 year.

Colleges will be able to combine classroom instruction and PLATO instruction as they wish and deliver instruction at remote locations, even at home for handicapped students.

Most of this lower division engineering curriculum can be used at the secondary level, and we are encouraging our higher education partners to reach out to secondary schools in their communities and States with these new science and math offerings.

A third curriculum is computer literacy. This integrated curriculum, which will eventually have 5 to 600 hours of teaching in this vitally needed field, not simply for people who are going into math and science, but for everyone in this new technological age.

Each of these foregoing efforts is a partnership. Advanced technology can significantly reduce the amount of time and money required to provide high-quality math and science education which is, after all, the whole point of H.R. 30.

Throughout my testimony, I have used the phrase "teaching capacity" and quite deliberately. We must begin to think about new ways of delivering math and science teaching to our young people. While increasing the number and proficiency of math and science teachers is critical, we now have available, unlike the late 1950's when we passed NDEA, new technology with enormous teaching capabilities.

To invest funds in an educational process that makes inadequate use of these technologies is like investing in a nonautomated plant, or one without adequate capital equipment. Surely, this bill can be phrased so that approaches such as those I have outlined are encouraged and supported, particularly under section 604.

In section 1(a), for example, the bill authorizes funds for teacher training and recertification in math and science. One of the key challenges of the 1980's is to make teachers comfortable with technology.

You will recall, Mr. Chairman, that in the late 1960's, there was a push for the use of technology in the classroom. But many teachers had very negative attitudes toward technology, especially computers.

Teachers feared that computers would interfere with their relationships with students or that the computers might even replace them in the classroom. Even receptive teachers found that educational technologists spoke one language and teachers another, and too often the technology was simply off the shelf programs, hard to adapt to individual student needs.

In many instances, the technology that we provided, and in many instances with Federal funds, was simply stored in schoolroom closets.

For today's teachers to learn to use available technology effectively and efficiently, they must be trained, and much of that training could take place in industries that are now training their own workers and managers to use advanced technology. Approaches such as this, however, are beyond the traditional recertification process specified in the bill. I would therefore suggest a broadening of the section that would allow the use of business resources for training.

In section 2, funds were available for the evaluation of local resources in math and science education. I would urge that such evaluations also include the training that business and labor now make available to their own employees and members. Creative partnerships might even make it possible for students to participate directly in these training programs.

In section 3, the bill provides for funds for plans for modernizing and expanding courses of instruction. You may want to follow the recommendation of the Office of Technology Assessment and consider subsidies to expand and upgrade the availability of quality software for computer-based learning.

Advanced learning technologies can do much to modernize and expand math and science courses, but we must avoid the temptation to simply put textbooks and rote learning on mechanical teachers.

We need, instead, to invest in creative problem solving uses of technology. I would urge, therefore, that funds from this section specifically be made available for the software development of sophisticated quality educational courseware.

In section 4, the bill speaks of the "development of innovative resources, including the use of emerging technologies and the development of curriculum." However laudable a concept, I would suggest that the reference be to the "use of advanced learning technology," the same term used, and quite deliberately, in the new Jobs Training Partnership Act.

Otherwise, we could appear to be encouraging schools simply to buy the newest piece of hardward, as the term "emerging" would suggest, rather than to acquire the most appropriate advanced technology.

I would also suggest that this section clearly authorize the use of funds for technologies for recordkeeping management of competitively based learning programs and other administrative tasks, so that teachers in the future have the time to do what they do best—and that is namely teach.

Finally, section 5 calls for the use of community resources, including those in business. There are many opportunities for creative approaches here, including providing businesses with incentives to loan employees to schools as teachers; we are part of the problem, we have lured teachers trained in math and science away from the schools, and I think we could be part of the solution.

The section could also consider school systems funds to enter joint ventures with businesses, such as the one I mentioned here in the District of Columbia. In encouraging more businesses to create new programs, as Control Data and other companies have done in the Warren-Sherman neighborhood in Toledo, where we provide students with part-time employment in high-technology plants during the school year and full-time summer employment.

These changes, Mr. Chairman, would in my view encourage the kinds of creative public/private partnerships that I think this section and the bill itself intends to foster.

Unless it does, however, with specific language, I fear the more traditional approaches, useful as they may be, will dominate the use of the funds.

Finally, I would like to comment on the postsecondary section of the act, though here I am expressing my personal observations, harkening back to some of the times when I was previously before this committee in another incarnation, so therefore I am not really here expressing the views of Control Data.

First, I believe that the merit-based scholarships provided by the act might more usefully be directed to teachers who are demonstrably dedicated to teaching and in need of skills upgrading.

In many schools, there are outstanding teachers who need or who would benefit from further education. Now they have few options except to spend four or five summers in obtaining recertification and upgrading.

Such teachers for the scholarships could be nominated by their peers, teachers know what teachers in their midst are good teachers. The scholarships, using the limited funds available in this section, the scholarships then could be directed to those recipients most likely to become lifelong master teachers.

Funds could be apportioned in proportion to a State's representation in the whole Congress. School systems or States could pay one-half of these teachers' salaries possibly, while the recipients attend graduate school, and the Federal Government the other half, thus creating a very significant partnership in raising the quality of training and teaching.

These dedicated teachers would undoubtedly return to their schools, they could help to train their peers, and of course, better teach their students.

Additionally, or alternatively, you may wish to focus merit scholarship funds on graduate students who are pursuing teaching careers. It seems only fair that such students should be rewarded and encouraged, especially at a time when so many graduate fellowships have dried up.

In my view, merit awards for dedicated teachers or promising graduate students interested in teaching are far more justifiable than merit awards to undergraduates who may or may not become proficient teachers or even enter teaching.

You, Mr. Chairman, I, many others on this committee and elsewhere, have in my view labored far too long to develop and nurture need-based undergraduate student aid programs rather than merit scholarships.

However laudable the objective, I would urge you and this committee not to stray from the hard-won victories of the past that were designed to expand equal educational opportunity at the undergraduate level.

Mr. Chairman, members of the committee, H.R. 30 is clearly focusing on a key problem, one that can be better addressed through effective partnerships that encourage the effective use of both human and technological resources.

Once again I thank you for this opportunity and I would be delighted to answer any questions you have.

Chairman PERKINS. Thank you very much for an excellent statement.

I notice around the witness table, we do not have room for the rest of the panel, and let me ask Dr. Yager to keep his seat and let those accompaning Dr. Yager take the seats immediately to the rear there. Immediately to the rear, and that will give us more room and you will be within the reach if questions come up a little later. If we do not have room back there, we will make room for you, so you can pull up your chairs and be around close.

Our next witness is Mr. John Casteen, Secretary of Education for Gov. Charles Robb, Virginia. You go ahead, Mr. Boucher, and introduce the gentlemen. Let him come around and take a seat here at this table.

Mr. **Boucher**. Thank you, Mr. Chairman. It is my pleasure to join with you here today in welcoming to the committee Dr. John Casteen, who, as you indicated, is the Secretary of Education in Governor Robb's cabinet in Virgina.

Mr. Casteen is a former professor of English at the University of Virginia and at the University of California at Berkeley and he was dean of admissions at the University of Virginia. He is here today representing the Education Commission of the States Task Force on Education for Economic Growth and it is my pleasure to join with you in welcoming him here today.

Chairman **Perkins**. Thank you very much, Mr. Boucher. Go ahead, Mr. Casteen.

STATEMENT OF JOHN CASTEEN, SECRETARY OF EDUCATION, FOR GOV. CHARLES ROBB, VIRGINIA; FLORETTA McKENZIE, SUPERINTENDENT, DISTRICT OF COLUMBIA PUBLIC SCHOOLS

Mr. **Casteen**. Thank you, Mr. Perkins, thank you, Mr. Boucher.

Mr. Chairman, I have brought today a written statement which I will not read——

Chairman **Perkins**. Without objection, all your written statements will be placed in the record in toto and you proceed any way you want to; if you want to summarize it, you may. Go ahead.

Mr. **Casteen**. I will summarize it with your permission.

Chairman **Perkins**. Go ahead.

Mr. **Casteen**. The statement begins with a brief description of the activities of the Education Commission of the States Task Force on Education for Economic Growth, the task force chaired by Governor Hunt of North Carolina.

It describes three major tasks that the task force has set for itself and describes the kinds of products the task force intends to offer to State leaders in assisting them to formulate educational policies that address many of the issues that are before your committee today.

The three tasks include, first of all, an attempt to identify the major needs of the States with regard to the kinds of graduates that our schools ought to produce as ways of inducing further economic growth.

Second, recommending specific policies, programs and actions State leaders can pursue in the service of those first purposes, and third, an attempt to develop sound leadership, both in the private sector and in Government to support the kinds of change in education that I think most of us at this point agree are appropriate, especially changes having to do with the kinds of complex academic skills in mathematics and the sciences and elsewhere that seem best to support the kinds of occupations that will expand in opportunity as our economy continues to change.

The second part of the written testimony is a survey of major educational initiatives announced by Governors in their recent state of the State addresses. The point of that section of the written statement is to provide for the committee a sample of the kinds of activity already in progress at the State level, and in particular to dwell both on activities that already exist, that already have funding and programs attached to them, and at the same time to indicate the shape of planinng for the coming year or 2 years, depending on the State's business cycle.

I think it is important to observe that in many States, Governors have acknowledged critical needs with regard to mathematics and science and, second, that they have attempted to relate those needs to the needs of industry and business as we attempt to deal with what many of us see as a new era in our technology.

Many of the States are working directly on the problem of dealing with the shortage of science and mathematics teachers, a shortage that is not universally distributed across the country, but that does appear in one form or another in virtually every State.

Many Governors have also attempted in one way or another to deal with the problem of adapting computer software and computer technology to the specific needs of teachers. I think it is fair to say that the efforts of several of the Governors, Governor Kean of New Jersey comes to mind as an example, parallel in many ways with the kind of testimony the committee has heard earlier today.

Finally, at the end of the written statement, I offer three brief suggestions concerning the legislation on which the committee has assembled today to meet, and that is H.R. 30.

The first observation I have tried to make is that State governance of education differs dramatically from one State to another and that the ability of States to use dollars in a productive way and to use Federal partnerships in a productive way, depends in part on the peculiar circumstances of the given State.

In some States, the State's chief school officer is well able to coordinate educational policy. Indeed, in some States, that officer has governance authority with regard to schools. In other States, including my own, authority is deliberately distributed to the feasible point that is closest to the place where we deliver the service so that our State board of education shares governance authority with local school division boards.

Our State Council of Higher Education, to move to another area of activity, coordinates and plans, but does not direct or govern the specific activity of the boards that govern our several institutions.

The point that I am trying to make with that observation, and the second basic point on page 5 of the prepared statement, is the change in education is very difficult to articulate from the national point of view, that, in fact, change occurs in different ways at different paces in different parts of the country.

I suppose that one way to paraphrase my second observation on H.R. 30 is that the committee may well want to spend some time gauging the prospect of causing change by any specific kind of Federal action and perhaps also to attempt to involve the States, especially the leadership of the States responsible for State school policy, in suggesting ways in which Federal legislation can achieve the maximum kind of benefit in the national interest.

Third, I have made a basic observation about a fear that we have in education, that we not return to an era in which we believe that merely directing at problems would solve them. The fact of the matter is that the structure of education in the States has from time to time been an impediment to well-intended Federal initiatives that might in one State have worked, but in other States, not have worked simply because our governance systems in schools reflect our peculiar local customs and activities.

I guess what I am asking is perhaps the legislation in the end ought to contain some mechanism to see to it that States gauge their own ability to drive dollars to programs that work, that States engage in some kind of partnership with the Federal Government in designing programs that will, in fact, deliver dollars to programs that work, and finally, that the intention of the Congress in funding this kind of legislation be realized in the end in the form of local programs that do, indeed, improve our performance in mathematics and science, improve the linkage between schools and business, improve the prospects that this year's graduates will be able to change in 5 or 10 or 20 years, to deal with economic conditions that are changing so rapidly now that no one expert can say with any real confidence what we will need to be doing in our high schools in as brief a time as a decade from now.

Thank you, Mr. Chairman.

[Prepared statement of John Casteen follows:]

PREPARED STATEMENT OF JOHN T. CASTEEN III, SECRETARY OF EDUCATION, COMMONWEALTH OF VIRGINIA

Mr. Chairman, I am John Casteen, Secretary of Education of the Commonwealth of Virginia. In that capacity, I serve as a Commissioner of the Education Commission of the State (ECS), and I act as staff to Governor Charles S. Robb, who sits as a member of the ECS Task Force on Education for Economic Growth. As you might imagine, I take great interest in the Committee's effort to frame national policy on mathematics and science education, areas of academic activity in which our erratic progress in recent years concerns all of us in education.

Everyone now acknowledges, I think, that the national issue framing the debate at the federal, state, and local levels for this year, for the Presidential election year, and certainly for the remainder of the 1980's, is the economy. The members of the ECS Task Force on Education for Economic Growth recognize that the quality of education delivered in this country figures heavily in this debate. The Task Force is addressing its attention particularly to the responsibility of state policymakers and business leaders in providing for our 45 million elementary and secondary school students the opportunity to graduate from high school with the knowledge and skills they will need to earn livings and to practice sound citizenship in tomorrow's economy. We believe that the members of this Committee may want to know about the approach taken by the Task Force, and also about certain possible products of the work done by the Task Force.

Governor James Hunt of North Carolina, current chairman of ECS, formally announced the creation of the National Task Force on Education for Economic Growth on December 9 at a press conference here in Washington. Frank Cary of I.B.M. and Governor Pete duPont of Delaware co-chair the Task Force with Governor Hunt. I have attached to these prepared remarks a blue-colored information sheet that contains a listing of all Task Force members. Our work, which will be completed in July, embraces three primary tasks:

1. Defining needs—that is, identifying the skills, abilities, attitudes, and behavior that workers need to master in order to contribute to and benefit by the new conditions of a modern technological economy. Our conversations with business and labor leaders have underscored judgments already well known to many of you. Some 85 percent of our high school graduates are now seen as lacking vital competencies in one or more of the disciplines that foster complex ability in problem solving, reasoning, conceptualizing, and analyzing. The business community uses the term "learning to learn skills" to describe these competencies. We in education tend to call then "higher-level" skills in our effort to distinguish them from the "basics" about which many citizens have expressed concerned in recent years. Attempting to define strategies that can bring together leaders in various areas of endeavor, the Task Force is

addressing the peculiar roles of governors, state legislators, business, labor, scientists, and educators generally in creating a national understanding of the need for these skills.

2. Recommending policies, programs, and actions for state leaders—that is, addressing such questions as what changes should we make in delivering educational services? How can we arrange for students to spend more time learning math and science? Should we lengthen the school day or year? Should the states certify new kinds of teachers (business people or scientists employed by industry or government, for example) to serve in classrooms? Which states have already succeeded in making schools more effective? What are the problems, costs, and unknowns when local and state leaders embark on programs to improve or reform their schools? who opposes change, and why? Which state leaders can make the most significant commitments if schools are to be improved? These and other similar questions will be before the Task Force when it meets here in Washington on February 26.

3. Asserting leadership to promote partnerships with business and industry, with the private partner sharing some part of the cost, human and material, of improving schools. In this regard, the Task Force is collecting information on what kinds of partnerships are already working, and where, and has begun compiling answers to important questions that proponents of such partnerships must answer: What framework is required if business is to remain an active partner with schools over a sustained period to time? What guidelines, regulations, and laws inhibit or encourage public/private partnerships of this kind? What are business leaders already doing to improve education? Which companies are helping schools identify the math and science skills needed for jobs (and future growth) in the new technologies? To what extent are business executives lending their skills to school people who want to improve management? Which companies are exchanging staff with schools, or releasing mathematicians and scientists for service in schools? And with what pay-offs for both partners? When the Task Force holds its final scheduled meeting in May, these questions will shape the discussion.

Supporting this effort, the Education Commission of the States is collecting state-by-state data on initiatives either proposed or already in place. I have attached to my prepared testimony a summary of state initiatives known to the Task Force in November.

One can quickly grasp the significance to the states of the issue of education for economic growth by examining the tests of the state-of-the-state messages delivered this month in all of our state capitols. Almost every governor is asserting that the states' own best interest requires that we succeed in this effort. Some typical examples:

Governor James Hunt of North Carolina, who as Chairman of ECS has asked each governor to declare 1982-83 the Year of the Public School, has based his legislative program on a careful strategy of investing in education and economic growth, in more jobs and better schools. His State-of-the-State message details a ten-step plan for the public schools developed with the primary goal of preparing people to work in a modern technological economy, and built on the following elements:

1. Continuing the state's strong kindergarten and primary reading program by placing a teacher and full-time aide in every classroom in grades K-3.

2. Retraining teachers who are presently teaching math and science out-of-field by providing $1,000 retraining grants for high school teachers to take college math and science courses and by funding a summer institute program to retrain 1,500 teachers in middle and junior high schools.

3. Strengthening recruitment of math and science teachers by redirecting the state's Prospective Teacher Scholarship Loan Program to those who plan to teach in these critical fields.

4. Providing funds for an additional six weeks of employment for one lead teacher of math and science in each of North Carolina's high schools. This teacher would work during the summer at improving science and math instruction for the entire school for the coming year.

5. Developing examples of "true excellence" in math and science by establishing model projects at elementary or secondary schools in each of the state's eight education districts.

6. Gradually increasing the minimum standards required for passing the state's competency tests, perhaps through the addition of questions in the science area.

7. Requesting the state board of education to increase high school graduation requirements by including at least two units each in math and science.

8. Increasing emphasis on "maximum competency" in schools by implementing the proposed North Carolina Scholars Program giving higher recognition to students who complete a more rigorous high school curriculum.

9. Increasing the number of science and math courses required for admission to the state's college and universities.

10. Continuing to build on the success of the North Carolina School of Science and Math in stimulating better math and science teachers in all of the state's public schools.

Governor Pierre duPont of Delaware has called on his Legislature to establish a state task force, under the direction of the state superintendent and state board of education, to focus on the shortage of math and science teachers. He has also called for a major Jobs Initiatives Package that includes using unemployment compensation funds as "education vouchers" for retraining purposes.

Governor Richard Snelling of Vermont has proposed an "early education initiatives" to enable local school districts to involve educators, parents, business, and community volunteers in programs that will include intensified instruction in math, reading, and writing, from pre-school through grade 3.

Governor Scott Matheson of Utah has proposed redefining the purposes of education in the elementary and secondary grades, and emphasizing the need to teach critical thinking—the ability to define a problem, seek relevant data, weigh evidence, and draw defensible conclusions, within the context of each subject.

Governor Robert Orr of Indiana in his State-of-the-State message presented "an agenda for excellence in the public schools," based on the preliminary recommendations of his Select Advisory Commission for Primary and Secondary Education. The Governor emphasized that this was an enrichment program, over and above the $2.8 billion in state funds recommended for public education. Governor Orr's agenda includes the following:

1. A requirement for a longer school year and a mandatory number of instruction days for all students.
2. An expansion of existing early grades, basic skills development, and gifted student programs.
3. A computer learning and training program to assist schools in evaluating computer instruction needs, teacher training and purchases of computer hardware and software for classroom use.
4. Funding to offset a critical shortage of math and science teachers through special financial assistance to students in schools of teacher education and to provide retraining for teachers presently qualified in disciplines in surplus supply.
5. Promotion of business and education partnerships through tax credits for summer employment of shortage area teachers and for donation of computer equipment to local schools.
6. A recommendation to reserve three positions on the state board of education for appointment of business leaders, to establish a greater linkage between public education and the business community.

Governor Thomas Kean of New Jersey has created a new Center for Information Age Technology at the New Jersey Institute of Technology in conjunction with the Governor's Office of Management. The Center will assist all levels of government in developing plans for computer applications, thereby providing increased services with reduced dollar and personnel costs. The Center will also work with the academic community to improve productivity. The Govenor's Commission on Science and Technology, established last year in New Jersey, has brought together the leadership of the state's major universities and industries to recommend new policies to stimulate development of research and educational programs to meet the demands of the high technology era. Recommendations are expected this fall. A separate Council on Math and Science Teacher Shortage has focused on how best to prepare math and science teachers and on how to retain qualified math and science teachers in public schools and colleges. This group will make its report in May.

Governor Charles S. Robb of Virginia has earmarked money in his proposed budget for the next fiscal year to provide essential post-graduate instruction for engineers and technicians already employment in the Richmond area, which currently lacks this service, and to make a state commitment to a proposed nuclear research laboratory to be jointly administered by the member instituations of the Southeastern Universities Research Consortium. In addition, he has proposed that the Virginia General Assembly fund a new program of comprehensive guidance publications that will stress the principles that students prepare themselves at each level of education for success at the next level, and that schooling builds toward the world of work. When fully implemented, this program will bring families and prospective employers directly into the process by which students plan their schooling.

As the states move to respond to this challenge, it is also appropriate that federal action be considered. With regard to H.R. 30, I can comment only from my perspective as a Virginia official, but I am eager to offer these few observations.

States will seek solutions to this problem through many different approaches, and these approaches will vary in complexity. Differences in governance, funding, and purposes guarantee that no one approach will work in all states. Sometimes the governor will take the lead; in other states, the legislature; in still others, the Chief State School Officer. In each state, the final recommendations and actions will almost certainly require collaboration among state, business, and local community leaders. I am not certain that your legislation in its current form acknowledges and builds solutions on the number of ways states are already responding or can respond with your help and leadership.

How carefully is the federal dollar being leveraged? I am not certain that the federal money will get down to where the problem is, as defined by the states and communities. Meaningful change in education, which I take to be one of your purposes in considering federal action, inevitably involves both confrontation and collaboration. The confrontations often pit education's own internal constituencies against one another. And the confrontations often find resolutions not in terms of goodness or purity of intention, but in terms of what is practically possible. Without doubting the Committee's awareness that opinions about how to improve education extend to infinite numbers, I think that it is proper to observe that new programs rarely succeed without tangible goals and more-or-less quantifiable purposes.

In Virginia, I work with both the Board of Education, which governs our elementary and secondary schools, and the Council of Higher Education, which plans and coordinates on behalf of the many boards that govern higher education, to define responsibilities and to seek solutions to problems that touch all levels of education. This essential structure exists in most of the states—one governing body addresses elementary and secondary education, while another (or many others) addresses higher education. We have realized in recent years that the two levels have common obligations and interests, that what was once seen as a natural animosity is neither natural nor productive. Collaboration at the state level to consolidate planning and to gain the greatest possible return on our education dollars has become common as we have tried in our several ways to end the old conflicts and develop new unity. I am concerned that the proposed legislation, with distinct pots of money for elementary and secondary schools and others for postsecondary institutions, may inadvertently retard the progress we are already making in these areas. I believe that our times require that states plan and coordinate strategies—a function quite different from governing education—from the perspective of each state's best sense of its own economic and social futures. To fragment or seem to fragment the sole process that seems to allow the states to deal with change as rapid as that of the last five years or that projected for the next five years may well not be the Congress's purpose. I hope that the legislation can eventually include safeguards against the random, unplanned expenditures in countless uncoordinated local efforts that sometimes characterized the federal efforts of a decade ago.

Finally, I believe that I can say for my colleagues in state government that we applaud your willingness to attempt to define the federal interest in this problem, and that we look forward to working with you in implementing whatever program you eventually adopt. We believe that we are making real progress in many places and in many ways. We share your optimism that our schools and colleges are adequate to the task of equipping Americans for life and work in a new kind of economy.

NATIONAL TASK FORCE ON EDUCATION FOR ECONOMIC GROWTH—INFORMATION SHEET

Sponsor: The Education Commission of the States (ECS), under the chairmanship of Governor James B. Hunt Jr. (North Carolina), current ECS Chairman.

Co-Chairmen: The Honorable Pierre S. duPont IV, Governor of Delaware Frank Cary, Chairman, IBM.

Membership: Thirty-three national leaders, including governors, legislators, heads of major corporations, education officials and representatives from labor, media and the scientific community compose the task force. Other business, industry, labor education and government leaders will provide a network of knowledgeable advisors to the task force.

PURPOSE

The task force will be action oriented . . . draw heavily on relevant data and resources that already exist . . . focus primarily on strategies for improving the quality of high school graduates, especially those skills required for economic growth

. . . and give momentum to the growing interest and concern among governors and corporate leaders for the quality of our public schools.

Specifically, the goals of the task force are:

1. Create national understanding of the need for a better educated work force that is necessary for economic growth.

2. Promote alternative policies, programs and actions to improve education which may be used by national, state and local leaders in both the public and private sectors.

3. Promote partnerships among community, business, labor, government and education leaders to improve education that will lead to economic growth.

Although the focus will be on education for economic growth, the task force will remain cognizant of other equally important purposes of public education, e.g., citizenship and personal growth.

Meetings: The task force officially meet in Washington, D.C. on February 26 and in Raleigh, North Carolina on May 4, 1983. Additionally, planning sessions attended by task force members or their designated staff will be held in late January and early April, 1983. An initial planning session was held in Denver on November 9–10, 1982.

Reports: The business of the task force will terminate with reports being delivered to the 1983 annual meetings of the Education Commission of the States (Denver, July 20–23) and the National Governors Association (Maine, July 31-August 2).

MEMBERS

Thornton "Brad" Bradshaw, Chairman, RCA Corporation and Chairman, Conference Board.

Bruce Brombacher, Teacher of the Year, Jones Junior High School, Upper Arlington, Ohio.

J. Fred Bucy, President, Texas Instruments.

Philip Caldwell, Chairman of the Board and Chief Executive Officer, Ford Motor Company.

James Campbell, President, MISSO Corporation; and Chairman, Education, Employment and Training Committee, U.S. Chamber of Commerce.

Frank Cary, Chairman of the Board and Chairman of the Executive Committee, International Business Machines Corporation.

The Honorable Wilhelmina Delco, State Representative of Texas.

The Honorable Pierre S. du Pont IV, Governor of Delaware.

Dr. Calvin M. Frazier, Commissioner of Education, Colorado.

Dr. William C. Friday, President, University of North Carolina.

The Honorable D. Robert Graham, Governor of Florida.

Dr. Anna J. Harrison, Professor Emeritus, Mount Holyoke College.

The Honorable James B. Hunt, Jr., Governor of North Carolina.

John H. Johnson, President, Johnson Publishing Company.

The Honorable Thomas Kean, Governor of New Jersey.

David T. Kearns, Chairman and Chief Executive Officer, Xerox Corporation.

Marvin O. Koenig, Principal, Southwest High School, St. Louis, Missouri.

The Honorable Richard D. Lamm, Governor of Colorado.

The Honorable Anne Lindeman, State Senator of Arizona.

Robert W. Lundeen, Chairman of the Board, The Dow Chemical Company; and Trustee, Committee for Economic Development.

The Honorable Scott M. Matheson, Governor of Utah.

Dr. Floretta McKenzie, Superintendent of Schools, District of Columbia.

Richard Monroe, President, Time, Inc.

Judith Moyers, Education Specialist, New York, New York.

The Honorable George Nigh, Governor of Oklahoma.

William C. Norris, Chairman of the Board and Chief Executive Officer, Control Data Corporation.

Bernie J. O'Keefe, Chairman and Chief Executive Officer, EG and G, Inc.; and Incoming Chairman, National Association of Manufacturers.

The Honorable Robert D. Orr, Governor of Indiana.

Dr. Frank Press, President, National Academy of Science.

The Honorable Robert D. Ray, Governor of Iowa.

The Honorable Charles S. Robb, Governor of Virginia.

The Honorable Richard L. Thornburgh, Governor of Pennsylvania.

Glenn E. Watts, President, Communications Workers of America.

Contributors: The following donors have provided support for the task force. Additional contributions would be most appreciated: Control Data Corporation, Texas Instruments, and Kellogg Foundation.

Additional information can be obtained from:

Dr. Robert Andringa, Executive Director, ECS (303) 830-3620.

Dr. Roy Forbes, Associate Executive Director, ECS (303) 830-3768.

Ms. Betty Owen, Policy Advisor, Governor's Office, Raleigh, N.C. (919) 733-6320.

EDUCATION COMMISSION OF THE STATES

Origin: Created in 1966 as an interstate compact.

Current membership: Forty-eight states (all but Montana and Nevada) plus Puerto Rico, American Samoa and the Virgin Islands have passed the necessary legislation to join. Each jurisdiction pays an annual fee to ECS and has seven voting Commissioners, most often including the Governor, a member of the House, a member of the Senate and four individuals appointed by the Governor.

Purpose: Service to state political and education leaders to improve the quality of education at all levels.

Primary constituency served: Governors, legislative leaders and their senior policy aides . . . chief state school officers, state higher education executive officers and their senior policy associates . . . state education boards . . . state leadership of local schools and campuses . . . and others who are not in these categories but who are appointed by governors as ECS Commissioners.

FUNCTIONS

1. Undertake policy research, surveys and special studies in response to the needs of state policymakers.
2. Serve as a clearinghouse of information about state policies and proposals, statistical information, research findings, and other sources of data.
3. Organize forums at the state, regional and national levels for ECS primary constituencies to exchange views, explore new ideas and build relationships.
4. Offer technical assistance including training programs, for individual states and defined groups of leaders.
5. Facilitate nationwide cooperation in education by providing information to the federal government and to national organizations, representing state interests in national forums, stimulating intergovernmental coordination and helping state officials exercise leadership beyond their state roles.

Governance: A Steering Committee, consisting of one Commissioner from each member jurisdiction, meets three times a year and includes various committees to oversee and guide the Commission between annual meetings of all Commissioners.

EXECUTIVE COMMITTEE

Governor James B. Hunt Jr., North Carolina (chairman).
State Senator Anne E. Lindeman, Arizona (vice chairman).
Governor Pierre S. duPont IV, Delaware.
Governor Robert D. Ray, Iowa.
Commissioner Sheldon H. Knorr, Board of Higher Education, Maryland.
Commissioner Harold Raynolds Jr., Education and Cultural Services, Maine.
Superintendent of Public Instruction Wilson Riles, California.
State Representative Gary D. Sharpe, Missouri.
Executive Director Harry M. Snyder, Council on Higher Education, Kentucky.

KEY STAFF CONTACTS

Robert C. Andringa, Executive Director.
Peggy Greene, Assistant to the Executive Director.
Aims McGuinness Jr., Assistant Executive Director.
Susan Adler, Director, Washington Office.
Gordon Ziemer, Associate Executive Director, Administration.
Roy Forbes, Associate Executive Director, Programs.
Allan Odden, Director, Policy Analysis and Research.
Beverly Anderson, Director, National Assessment Program.
Shirley McCune, Director, Technical Assistance.
Russ Vlaanderen, Coordinator, Information Clearinghouse Services.
Rex Brown, Director, Publications Department.
John Augenblick, Director, Finance Center.
Patricia Lines, Director, Law Center.

Donald Burnes, Director, Governance Center.
Louis Rabineau, Director, Leadership Development.
Gloria Frazier, Director, State Education Policy Seminars.
Bill Hilton, Director, Lifelong Learning Project.
Edith Petrock, Director, Energy Education Project.
Vicente Serrano, Director, Migrant Education Project.

Budget: New grants and contracts are likely to alter the approved budget for fiscal year October 1, 1982 to September 30, 1983:

BUDGET

Administered internally	Amount	Percent
State membership fees and miscellaneous (unrestricted)	$1,433,478	25
Contracts with States	316,735	5
Federal grant: National Assessment (NAEP)	3,114,231	56
Other Federal grants/contracts	201,461	4
Foundations (5)	498,387	9
Other	26,136	1
Subtotal	5,590,428	100
External NAEP contracts	305,390	
Total	5,895,818	

STATE ISSUES

ECS has substantive staff capability to assist states in the areas of education finance, law, governance, education quality improvement, and assessment and evaluation. Examples of the variety of issues on which ECS assists states include:

Finance (K-12 and postsecondary);
School improvement;
Nationwide trends in reading, mathematics, science and other knowledge areas;
Education governance;
Public policy and private schools;
Teacher quality and supply; and
Education of special populations (migrant, handicapped, etc.).

OFFICES

Headquarters: 1860 Lincoln Street, Suite 300, Denver, Colorado 80295 (303) 830-3600.

Washigton, D.C.: 248 Hall of the States, 444 N. Capitol Street NW, Washington, D.C. 20001 (202) 624-5838.

[From the Education Commission of the States Task Force on Education for Economic Growth]

Preliminary Results of a Survey of State Initiatives in Education

BACKGROUND

One of the biggest challenges facing American education is the development of policies and programs to help students meet the needs of a high technology economy. Recent advances in technologies related to electronics, communications, information transmission, and molecular biology will have a dramatic effect on the skills students will need to be productive workers in a growth economy. Competencies in the fundamentals of reading, writing and computation must continue to be the foundation of a sound education. They need to be supplemented, however, by higher-level conceptual, reasoning, analytical, and problem-solving skills—skills facilitated by study of the mathematical, computer, natural, and biological sciences.

Unfortunately, as many recent studies have shown, significant deficiencies exist in the quality and quantity of science and mathematics education in our public schools. Student enrollments and achievement have been declining over the past 20 years. Qualified teachers are in short supply. The curriculum and facilities are inadequate to prepare all the students to work and live in an increasingly technological society.

States, with the constitutional responsibility for elementary and secondary education, must take the lead in redressing these deficiencies. Substantial human, institutional, financial, and political resources will be required. They will be obtained only if governors and other state political and education leaders are joined in this endeavor by leaders of business and industry, higher education, science and engineering, and the general community.

In recognition of the necessity of these partnerships for improving elementary and secondary education, Governor James B. Hunt, Jr. of North Carolina, as the new Chairman of the Education Commission of the States (ECS), has established an ECS Task Force on Education for Economic Growth. The Task Force consists of governors, business and industry leaders, representatives of labor, the technical community, and all levels of education. The goal of the Task Force is to stimulate each of these groups to initiate activities, individually and collectively, aimed at improving the capabilities of high school graduates to contribute to economic growth.

The initial activity of the Task Force has been directed toward governors themselves, as the officials responsible for guiding the state leadership that is required. Governor Hunt requested all of the governors to report on programs and activities underway in their states which address educational problems and opportunities. This document is a summary of the information obtained. It is intended to assist the governors in assessing their current programs, in designing new and improved programs, and in formulating their legislative proposals over the coming year.

The Task Force will obtain more detailed information on state and local initiatives in education for economic growth in early 1983. Additional Task Force activities will be getting underway in the next couple of months. Information on the complete Task Force work program will be available at the winter meeting of NGA. If you have any questions about the Task Force, please contact Roy Forbes at ECS (303-830-3768), Betty Owen (919-733-6320) or Don Phillips (919-549-0671) in the Office of the Governor in North Carolina.

SURVEY RESULTS

The governors were asked to provide information on activities concerned with:

Improving student competencies in mathematics, science, computers, and other academic areas;

Using computers to improve education;

Providing incentives for attracting, retraining and upgrading education personnel, especially science and mathematics teachers; and

Involving citizens and business and industry leaders in education.

Almost forty states have responded to date. Although each state reported a unique set of initiatives for each problem area, most of the responses fit into one of three categories:

Task forces to study the issues; define the problems, needs and opportunities and recommend new policies and programs;

Programs to enhance quality and quantity of curriculum, facilities, students, and teachers; and

Programs to encourage broader involvement in education by citizens, business and industry.

A brief overview of the types of activities in each of these areas is presented below.

TASK FORCES

The task forces reported in the survey dealt with nearly every conceivable education issue facing the states. Task force agendas included consideration of:

Programs to achieve excellence in the high schools, including re-evaluating the nature and role of the high school, determining appropriate goals and curricula for various categories of students and revising high school graduation requirements;

The structure of the teaching profession, the nature of teacher training programs and the future simply and demand of teachers, especially in science and mathematics;

Computer literacy goals and curricula for students in grades K-12 and for teachers and administrators;

A central state-wide advisory service for computer software;

Mechanisms to involve business, education and labor in educational planning and policy, decisionmaking and evaluation;

Strategies to expand a state's economy and employment rate through improvements in education and training; and

Manpower projections and vocational and technical education to meet the needs of the state's industries.

ENHANCING PROGRAM QUALITY AND QUANTITY

Every state has implemented programs to improve educational quality. To increase the effectiveness of its educational systems states are:

Developing new orrevised curricula, especially in science, mathematics and computer literacy in grades K-12. Most states have develop curriculum guides, statements of minimal competencies or curricula goals which students should meet upon graduation. Many states are moving beyond minimal competencies and are requiring "standards of excellence" and strengthening existing programs;

Emphasizing a shift in the curriculum to teach concepts, applications, problem solving and critical thinking;

Providing technical assistance (using on-site workshops or regional centers) in such areas as computer literacy, clarifying course goals, curriculum design, student and program evaluation and the use of the results of reserach on effective educational practices;

Introducing college level course in high school (such as Calculus);

Introducing computer assisted instruction (CAI) or national information systems such as Porject BEST to increase student learning and achievement;

Purchasing new equipment, including computers and software;

Reducing the number of "at-risk" students by providing additional training and job placement services; and

Establishing local pilot programs to develop strategies that can be effective on a state-wide basis.

ENHANCING STUDENT QUALITY AND QUANTITY

States have attempted to increase the number of students taking science and mathematics and to improve their skills, abilities and capabilities by:

Increasing high school graduation requirements so that students are required to take 3-4 years of high school mathematics, 2-3 years of science, 4 years of English and one or more years of a foreign language;

Increasing the entry requirements in science and mathematics in state supported colleges and universities.

Lengthening the school year;

Implementing student testing for assessment and minimal competency purposes. Some testing is aimed at minimal competencies for graduation; other state assessment programs cover a wide variety of learning areas and are used to locate student or program weaknesses.

Creating special schools or specific centers to promote learning by gifted students in areas such as science, mathematics and computer literacy; and

Initiating child development programs for pre-school children; home-based programs for parents of pre-school children; and workshops for parents on early childhood development.

ENHANCING TEACHER QUALITY AND QUANTITY

Issues regarding teacher quality and shortages are being addressed by:

Revising teacher certification requirements. Depending on the state, teachers may be required to pass an entry exam prior to being enrolled in an undergraduate teacher education program; pass a written examination before being certified as a teacher; a pass practice teaching standards; take additional courses in the subject area; successfully teach for two years after graduation; and obtain a certain amount of additional training every five years to keep a teaching certificate current;

Providing tuition and scholarship programs. In some instances, states have set aside funds to assist teachers in obtaining training in areas where there are shortages of teachers, such as in science and mathematics.

Making student loans available to prospective teachers. In many cases, the loans are forgiven if the teachers remain in the state to teach for several years;

Providing 12-month contracts to teachers in critical areas (science, mathematics, vocational education). The summer months are used for curriculum development, retraining, course preparation and special group instruction;

Providing internships to alleviate the teacher shortage in science and mathematics. In several states, science and mathematics teachers work for private industry as "interns" during the summer, helping them to increase their salary and learn new skills. On the other side, many large corporations are allowing their qualified professionals to teach science or mathematics classes several hours per week in local schools;

Providing inservice programs so that teachers' skills can be updated and improved. Some states are initiating summer institutes at universities where teachers can enroll to update their skills. Many states offer traveling workshops to school districts where technical assistance is provided, especially in the teaching of computer literacy;

Increasing teachers' salaries, either across the board or in areas of teacher shortages;

Working with high school guidance counselors to help recruit good students into the field of teaching; and

Assessing the present and future teacher supply and demand for future planning.

BROADER INVOLVEMENT OF CITIZENS, BUSINESS AND INDUSTRY

A number of initiatives have been undertaken at the state level to encourage participation by broader segments of the community in the educational process. Initiatives reported are:

State-wide and local task forces involving business, industry and labor leaders as well as parents and concerned citizens in all areas of educational planning, decision-making, implementation and evaluation as mentioned above;

Advisory councils for vocational education programs;

Efforts to obtain input on educational priorities from a broad cross-section of interested parties;

The matching of state funds with private sector donations to secure faculty, equipment and up-to-date programs at state institutions;

Statutory changes to promote cooperative research and development efforts between colleges and universities and industry;

Training of school personnel by industry technicians to use state of the art equipment;

Adopt-a-school and partnership programs with business and industry; citizen volunteer programs in schools;

Team teaching using teachers and industry employees;

Customized job training to meet specific needs of industry within a state; and

Workshops to involve parents in helping their children learn to read.

Chairman. PERKINS. Thank you for the statement, Mr. Casteen.

Our next witness, Ms. Floretta McKenzie, Superintendent, District of Columbia Public Schools, representing the Council of Great City Schools.

We are glad to welcome you here and you go ahead.

Ms. MCKENZIE. Thank you so much, Mr. Chairman, members of the committee, I am very pleased to be here today to speak on behalf of the Council of Great City Schools.

As the chairman knows, the council is an organization comprised of the Nation's largest urban school systems, including the D.C. public schools. This is perhaps the only education organization whose membership is solely urban.

The council's membership serves 5 million inner-city young people, 30 percent of whom live in families receiving public assistance, and 75 percent of whom are minorities.

I will summarize my testimony in providing for you the council's perspective on the issue of math and science education and make a number of recommendations to the subcommittee on the proposed H.R. 30.

I would like to let you know from the onset that the council views the proposed bill favorably. A great deal of discussion has been heard over the last years about the poor health of our mathematics and science instruction in the United States. The National Assessment for Educational Progress has indicated a decrease in the mathematic scores of our secondary school students nationwide and the College Entrance Examination Board, through the SAT, has also documented a decrease in scores over the last 20 years.

As we look at a report prepared for the National Science Foundation in 1980, comparing the education systems of the United States and the Soviet Union, we find that the Soviet Union produces six times more individuals in the engineering fields than does the United States, and Japan, with half the population of the United States, graduates as many engineers as we do.

A number of factors have been identified as responsible for this problem: Teacher shortages, reductions in Federal and State education funding, competition with the private sector for skilled personnel and others, including general student dislike, a perception of general student dislike for science and mathematics.

Mr. Chairman, I would like to highlight a special aspect of this growing problem.

Chairman **Perkins**. Go ahead.

Ms. **McKenzie**. This has received little attention in any of the currently proposed math, science bills, and that is the low participation rate of minorities and females in technical fields.

In a country desperately in need of technical personnel, of the approximately 2.7 million scientists in the Nation in 1978, only 1.5 percent were black, and only 5.2 percent were female, according to the National Science Foundation.

This low participation rate of blacks and women in the technical fields can be traced in part to differences among the groups in graduate, collegiate, and precollegiate training. In addition, blacks and women who serve as role models to undergraduate students continue to be underrepresented on the faculties of mathematics and science departments.

Much of the problem begins in our elementary and secondary schools. Data being gathered now by organizations indicates that city schools are having a much more difficult time recruiting and retaining math and science teachers than other kinds of school systems. We are often filling slots with noncertified instructors.

New data are also emerging to show that the tools needed to train students for technical fields are lacking to a greater extent in poorer school districts. Therefore, we are facing an equity issue in instructing our young people, particularly using the newer technology.

The situation that I have outlined has substantial implications for city schools that contain large populations of minority youth and, of course, we are well aware of this undeveloped human capital.

The new legislation will only widen the gap between poor and nonpoor schools, and consequently between poor and nonpoor citizens if we are not very careful.

There is another aspect of the same issue that has national implications and involves the changing composition of our population and labor force. The National Center for Labor Statistics estimates that between 1980 and 1990, the overall minority school age population will increase by 4.9 percent, while the white population will decline by 9 percent. By 1990, the youth cohort will be 30 percent minority nationally, and in States such as California and Texas, that figure will reach as high as 45 percent.

At the same time, these groups move into the labor force, the market will be asking for individuals more highly trained in technical skills. If the United States is to remain competitive in the new technology on domestic and international fronts, then a larger share of those who have not participated in the past will have to be included.

In addition, a recent report by Hal Hodgeson points out, and I quote, "The secure retirement of today's 45 year old white worker will be increasingly dependent upon the economy's ability to generate jobs for higher percentage of minorities and today's youth."

He goes on to conclude, "Thus, for the first time, we are faced with a two-nation perspective on educational policy."

The Council of Great City Schools has a number of general recommendations with respect to this issue, and I will summarize those. I indicated already that the council recommends that the new proposed legislation be favorably reported from committee and the Congress as soon as feasible.

Second, the council recommends that the funding for the math/science field be targeted on those districts with high need.

Third, the council recommends that the use of funds under the bill allow schools to establish magnet schools or magnet programs for mathematics and science and computer technology. We will not only through this recommendation address the math/science needs, but also assist in desegregation efforts.

Fourth, the council recommends that incentives be established in the bill that would encourage the cooperation of local public school systems, the private sector, urban universities, in designing curricula, filling teacher shortages, and guaranteeing jobs.

Fifth, the council recommends that the new program retain its local base, that is, distributing funds through the States to local school systems in an attempt to grapple with this problem.

And, last, the council recommends that the bill's resources be used predominantly to meet the goals and objectives arrived at through local planning and needs assessment identified in the first year, and that strategies for retraining teachers to close the apparent shortage be detailed in such plans.

The council would like to commend the chairman and the committee for its leadership in addressing this national problem so swiftly. The Great City School Council stands ready to assist you in this effort.

Thank you so much.

[The prepared statement of Floretta McKenzie follows:]

PREPARED STATEMENT OF FLORETTA MCKENZIE, SUPERINTENDENT, DISTRICT OF COLUMBIA SCHOOLS

My name is Floretta McKenzie and I am the Superintendent of the Washington, DC, Public Schools. It gives me great pleasure to appear before you on behalf of the Council of the Great City Schools.

As the Chairman knows, the Council is an organization comprised of the nation's largest urban school systems including my own. On its Board sit the Superintendent and one Board of Education member from each district, making the Council of the Great City Schools the only national organization so constituted and the only education coalition whose membership is solely urban. The Council's membership serves nearly 5 million inner-city young people, 30 percent of whom live in families receiving public assistance and 75 percent of whom are minorities.

In this testimony I would like to share with you the Council's perspective on the issue of math and science education and to make a number of recommendations to the Subcommittee on the proposed Emergency Mathematics and Science Education bill, H.R. 30. I would like to state that the Council views the proposed bill favorably.

A great deal of discussion has been heard over the last year or so about the poor health of our Science and Mathematics establishment in the United States. The evidence is straight forward and convincing. The National Assessment of Educational Progress has shown a marked decline in the Mathematics scores of secondary school students nationwide, and the College Entrance Examination Board has reported steady decreases in Math scores over the last twenty years on the Scholastic Aptitude Tests (SAT).

The problem appears worse in comparison with other countries with which we compete. Japan, for instance, which has a population half that of the U.S., graduates as many engineers as does this nation. A recent study by SRI International[1] showed that U.S. elementary schools devote fewer total hours of instruction to Mathematics, teach fewer students in these subjects at the secondary grades, and have less well-developed technical curricula than does the U.S.S.R. The problem is more evident at the post-secondary level where the Soviet Union graduates up to 6 times more individuals in the engineering fields than does the U.S.

The situation in the U.S. has been listed as partially responsible for a variety of national problems: trade deficits, defense manpower shortages, lower productivity levels, and growing pools of undeveloped human capital.

The causes of the new shortages in the Math and Science fields have been placed at the doorstep of a number of factors: teacher shortages, reductions in federal and state education funding, the competition with the private sector for skilled personnel, the drain that the military puts on goods-producing industries, reductions in monies for research and development in technical fields, the lack of cooperation between schools and industry on the skills needed for fast-growing occupations, general student dislike for Science and Mathematics, and others.

Mr. Chairman, I would like to highlight a special aspect of this growing problem that has received little attention in any of the currently-proposed Math/Science bills: the low participation rates of minorities and females in technical fields.

In a country desperately in need of new technical personnel, minorities and women continue to be shot out of scientific fields in ordinate numbers. Of the approximately 2.74 million scientists in the nation in 1978, only 1.5 percent were Black and 5.2 percent were female according to the National Science Foundation.[2] These percentages were reached after a 25 percent increase in the participation of racial minorities between 1974 and 1978 and a 32 percent increase in the participation of women. Even within the scientific fields, Blacks receive an average salary that is almost 10 percent less than Whites. In combination with the present 20 percent unemployment rate for adult Blacks, a large number of racial minorities and women are being excluded from a chance to break onto one of the scientific or technical occupations.

This lower participation rate of Blacks and women in the technical fields can be traced in part to differences among the groups in graduate, collegiate, and pre-collegiate training. In 1979, Blacks earned 6 percent of the Bachelor's degrees in the scientific fields, 4 percent of the Master's degrees and 3 percent of the Doctorates. By contrast, about 11 percent of high school graduates are Black and 50 percent are female.

At the collegiate level, only 9.3 percent of the total higher education enrollment is Black, and nearly 37 percent of all Blacks in college were in traditionally Black Colleges or in two-year colleges, which tend to have fewer financial resources than other higher educational institutions. Studies of career and academic paths for Blacks and Whites at the collegiate level indicate that Blacks continue to favor health and social science tracks while Whites favor more technical fields. In addition, Blacks and women who could serve as role models to undergraduate students continue to be underrepresented on the faculties of Mathematics and Science departments.

---

[1] SRI International. "A Summary Report on the Educational Systems of the United States and the Soviet Union: Comparative Analysis," prepared for the National Science Foundation; Washington, D.C., 1980.

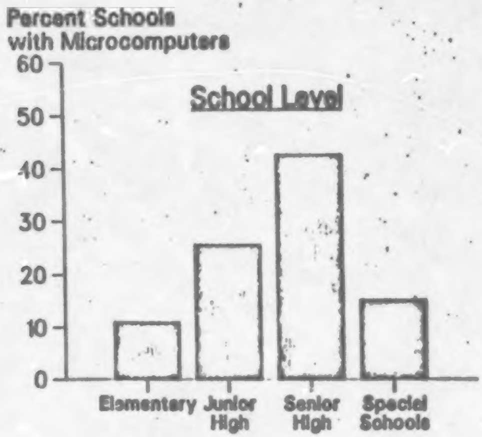
[2] Cited in Scientific Manpower Commission. "Professional Women and Minorities: A Manpower Data Resource Service." Washington, D.C., April 1982: Table G-WF-37, p. 100.

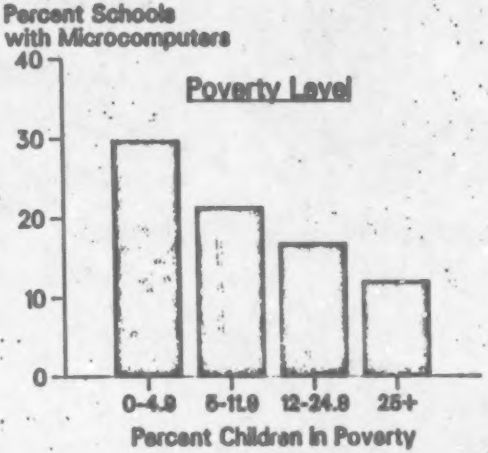
Much of the problem begins, however, at the elementary and secondary school level. The National Longitudinal Study has found, for instance, that Black and Latino students take fewer courses in Algebra and Geometry than do Whites, and are enrolled in fewer advanced or honors Mathematics classes. In addition, fewer minority students take the advanced portion of the SAT's whose scores are often needed for admission into science majors at the college level.

The causes of these disparities are varied, some within the purview of this Subcommittee and some not. Racial and gender discrimination continues to play an unfortunate but significant role in who society accepts for which occupations. A major part of the problem, however, is one of resources. Minority students remain concentrated in school systems with the poorest financial resources. The thirty school systems that comprise the Council of the Great City Schools enroll about 55 percent of all the Black and Latino students in the nation, and continue to hover near the brink of insolvency. Data being gathered now by the organization indicates that the city schools are having a much more difficult time recruiting and retaining Math/Science teachers than other kinds of school systems, are filling slots more rapidly with noncertified instructors, and have older more out-dated Science text books because of funding shortages.

New data are also emerging that show that the tools needed to train students for the technical fields are lacking to a greater extent in poorer school districts. A study by Market Data Retrieval now shows that microcomputers are increasingly available to American school children, but that schools with the largest number of children in poverty have substantially fewer microcomputers than schools with fewer such children (see chart). The Educational Research Service has found that urban schools have fewer computers available for instructional use than other kinds of districts. The Council's own survey of its membership also finds that the city schools are less likely to spend its new Chapter 2 monies on microcomputers than other schools because of differing and conflicting needs.

MICROCOMPUTERS IN SCHOOLS, 1981





- Microcomputers are increasingly available to American schoolchildren.

- Schools with the largest number of children in poverty have substantially fewer microcomputers than schools with fewer children in poverty.

Source: Market Data Retrieval

The situation that we have outlined has substantial implications for city schools that contain such large proportions of minority youth. Our fear is that the new legislation will only widen the gap between poor and nonpoor schools, and consequently between poor and nonpoor citizens.

There is another aspect of the same issue, however, that has national implications, and involves the changing composition of our population and labor force needs. The National Center for Education Statistics estimates that between 1980 and 1990 the overall minority school age population will increase 4.9 percent while the White will decline 9.0 percent. By 1990 the youth cohort will be 30 percent minority nationally, and as high as 45 percent in some states like California and Texas. Enrollment in private two-year colleges and four year colleges is expected by NCES to drop by the late 1980s while the enrollment in two-year public institutions, where many minority students attend, will remain constant. In general, the student cohort will increasingly be from minority backgrounds, from single-parent families (normally female-headed), and others that have traditionally had lower participation rates in society's benefits.

At the same time that these groups move into the labor force, the market will be asking for individuals more highly trainied in technical skills. The Monthly Labor Review estimates that the most rapidly growing occupations in the 1980s will be in the high technology fields: data processing mechanics (148 percent increase by 1990), computer analysts (108 percent), programmers (74 percent), computer operators (88 percent), and office machine service personnel (81 percent).

If the United States is to remain competitive in the new technology on the domestic and international fronts, then a larger share of those who have not participated in the past will have to be included. In addition, a recent report by Harold Hodgkinson of the National Institute of Independent Colleges and Universities points out that "The secure retirement of today's 45-year-old White worker will be increasingly dependent upon the economy's ability to generate jobs for a higher percentage of minorities among today's youth." He goes on to conclude that "Thus, for the first time, we are faced with a 'two-nation' perspective on educational policy . . .".

The Council of the Great City Schools has a number of general recommendations for the modifications of H.R. 30 but pleads with the Committee to take serious consideration of the issues raised here and to continue to press for legislation aimed at improving Math/Science capabilities.

COUNCIL RECOMMENDATIONS FOR H.R. 30

1. The Council recommends that the new proposed legislation be favorably reported from Committee and the Congress as soon as is feasible.

2. The Council recommends that funding for the Math/Science bill be targeted on districts with high need. We would recommend that funding for the entire program be based on a national formula similar to that under Chapter 1 (ECIA), and that the 25 percent set-aside for in-state distribution be determined by a Congressionally-set formula for schools with the highest concentrations of needy children. The most recent legislation that allowed the Secretary of Education to establish criteria for the distribution of funds was Chapter 2 and the result was severely detrimental to poor and urban school systems.

3. The Council recommends that the use of funds under the bill allow schools to establish magnet schools or magnet programs for Mathematics, Science, and computer technology. Among the many problems of the urban schools, the issue of school desegregation continues to be paramount. One possible strategy for addressing both desegregation and Math/Science needs would be to design open-enrollment specialized programs in city schools that would enhance the curricula and would attract students of all races throughout the metropolitan area.

4. The Council recommends that incentives be established in the bill that would encourage the cooperation of the local public school system, the private sector, and the urban universities in designing curricula, filling teacher shortages, and guaranteeing jobs. New pilot programs in Washington, Boston, and Milwaukee are moving in this direction and might provide excellent models for the legislation The private sector has been particularly instrumental in designing technical curricular in some cities that would match the needs of local employers.

5. The Council recommends that the new program retain its local base, i.e., distribute funds through the states to local school systems that are now attempting to grapple with the problem.

6. The Council recommends that the bill's resourcers be used predominantly to meet goals and objectives arrived at through local planning and needs assessments

identified in the first year, and that strategies for re-training of teachers to close the apparent shortage be detailed in such plans. We believe the bill should focus on problem identification at the local level.

The Council would like to commend the Committee, and its esteemed Chairman Carl Perkins, on the leadership it has taken in addressing this national problem so swiftly. Our office stands ready to assist you in any way as the bill works its way through Congress.

Chairman PERKINS. Thank you very much.

We will go on now to Mrs. Joanne Goldsmith, president of the National Association of State Boards of Education. We are glad to welcome you here this morning. Proceed in any manner you prefer.

STATEMENT OF JOANNE T. GOLDSMITH, PRESIDENT, NATIONAL ASSOCIATION OF STATE BOARDS OF EDUCATION

Ms. GOLDSMITH. Thank you, Mr. Chairman. It is nice to be here this morning, Mr. Chairman, members of the committee, and distinguished panel members and old friends.

My name is Joanne Goldsmith, I am president of the National Association of State Boards of Education, which represents education policymaking bodies in nearly all States, the District of Columbia, and U.S. trust territories. I am also president of the Maryland State Board of Education.

I am extremely pleased to be here this morning and have the opportunity to testify on behalf of NASBE member boards on H.R. 30, the Emergency Mathematics and Science Education Act.

I would begin, Mr. Chairman, by heartily endorsing your choice of the word "emergency." Although there is much talk these days about the needs to prepare the coming generation for the increasingly technical and scientific world in which they will live and work, we have yet to back up our words with deeds. If we do not act, and act swiftly and wisely, we believe that we will forfeit our future.

I am reluctant to recite for you once more the familiar litany of the sorry state of our preparation in this area, the severe shortages of qualified mathematics, science, and computer teachers, the use in many States of unqualified personnel because no one else is available, the lower achievement of American students in science and math compared with our counterparts in the Soviet Union, Japan, and other nations, the pressing needs of American business and the military for mathematically and scientifically trained youth.

To document this disturbing trend, I am attaching evidence at the end of my statement for your perusal. By now, nobody should need convincing that the problem we are facing is a very serious one. We know, for instance, in the State in which I live, last year, this past June, we graduated only eight math teachers, only six of whom were going to enter into the public school system to teach mathematics. That is frightening when we look around the Nation and look at the numbers and the needs.

The question is whether we will have the will and the wisdom to act and to act together at all levels of government, Washington, the States, the local school systems. We believe we must work together in order to reverse this trend once and for all.

We know that a number of States have already begun to move seriously on this problem. Your own State of Kentucky, Mr. Chairman, has created a student loan forgiveness program to attract future science and math teachers. Other States have begun reforming curriculums, forming regional cooperatives to share such materials as computer software programs and creating summer institutes or workshops for instructors in math and science.

Many local school systems are also taking whatever steps their budgets permit to meet this challenge, and we know that it is very difficult for them.

The dimensions of the problem and the consequences for our national economy and our national defense far transcend the capacities or the responsibilities of any one State or local school system.

We believe the need for math and science teachers is a national problem, an even larger one than has been generally imagined. It must be remembered that in the area of trained personnel, we are not merely talking about the immediate needs of the schools; we are talking about the competing needs of business and our defense establishment, both military and civilian.

It is now commonplace across the Nation for the best mathematics and science teachers to be lured away from the classroom by business and industry, adding to the already severe shortages in the schools.

We must train enough people for both the teaching profession and for business, industry, and the military. We believe we must, because if we do not, we will be limiting our investment in our future, and we will not have a guarantee of a future life. We really think that we are guaranteeing ourselves to failure if we do not work with business and industry with our teachers of science and math.

We believe it is essential, therefore, to begin a substantial Federal investment in this area. We recognize that in light of current Federal budget restraint, it is unrealistic to expect this investment which will eventually require billions of dollars to be forthcoming all at once, but we can make a decent start this year at the Federal level.

I therefore wish, on behalf of NASBE, to commend you, Mr. Chairman, for the essential beginning represented by your measure. If enacted, as I believe it must be, it can provide the kind of momentum necessary to start the whole country moving in the right direction, and hopefully lead to the larger Federal investment that will be needed to achieve the excellence that we believe we can attain.

Your immense store of expertise in the education area shows quite clearly in this bill. The measure covers almost every area of critical need related to science, math and computer instruction.

All the permissible funding areas are vital: Fresh training for existing math and science teachers, congressional scholarships to help attract outstanding new teachers, the promotion of computer literacy, assistance in acquiring new equipment and many additional efforts, all of which are essential.

I would, however, raise one question. Given the very limited funding necessarily proposed, is it wise to spread the aid so thinly among every school system in each State? Or would it be more effective to allow States to concentrate the funds where they are most urgently needed and where they can produce the most results?

At the elementary and secondary level, for example, the measure would authorize a maximum allocation of $250 million. Of this sum, $178 million would have to be divided among all local school systems according to a formula based on student population.

With approximately 16,000 school districts in the Nation, this means that an average school district would receive little more than $11,000. I need scarcely say that $11,000 would not allow that school system to accomplish much if anything.

In addition, a maximum of about $60 million would be distributed according to regulations established by the Secretary of Education. If this were divided among all school districts, it would mean an average of only $3,750 more per school district.

The sole criteria for these regulations, again, is student population with the number of children from low-income families the only example cited. Neither of these provisions appear to have as its primary consideration the areas of each States with the most crucial needs.

In which areas do employers have the most pressing need for mathematically and scientifically trained graduates? I understand full well the commendable desire to see that no local school systems are neglected, and particularly that disadvantaged students are not shortchanged.

Indeed, if it were possible, I personally would like to see assurances that female students who have been too often discouraged from entering scientific fields will also receive equitable treatment under the act.

The National Center for Education Statistics estimates, for example, that only 26 percent of female high school students take mathematics for 3 or more years. Yet women will make up a striking two-thirds of new workers entering our increasingly technically oriented work force in this decade.

Chairman PERKINS. Let me interrupt just a moment.

Ms. GOLDSMITH. Yes, sir.

Chairman PERKINS. I do not think any of the members will take exception to what I am going to say, but you have got such a variety of viewpoints about the administration of these funds, because there is such a little amount. I take it that you want the State boards to make the allocations within the State, and I take it that the lady preceding you from the Greater Cities, if I understood her correctly, she said that even $5,000 would be of tremendous benefit to the inner cities.

Now, how can we reconcile this difference between you two ladies sitting right there? Why don't you express yourselves——

Mr. GOODLING. You do not have to stop at two ladies. You can go right down the line and ask all three ladies sitting together.

Chairman PERKINS. All three ladies go ahead if you want to comment on it, just briefly.

Ms. GOLDSMITH. They claim that fools rush in where angels fear to tread and I will attempt an answer.

We think that the State boards of education have constitutional responsibility for looking at total education responsibilities in each

State. We think that there can be an equitable formula that will take into account the needs of each school district, including certainly the large cities.

We think that it can be worked out, taking advantage of student counts similarly to what we are doing with chapter I and chapter II of the block grants where we are in some cases giving weighted numbers to handicapped, to disadvantaged. We obviously would like to include women and minorities. We think equitable formulas at the State level would, in fact, give us some maneuverability.

Frankly, $1,000 for in-service in a small school district is not going to give us an awful lot of milage. We do not think that there is one way to teach young people. With all due respect to computer teaching, we think you need a classroom teacher. We do not think $11,000 is an adequate salary for a teacher. We think working together with our economic development people, we can develop——

Chairman **Perkins**. Ms. McKenzie said the opposite there a while ago. Let's let the lady from the Greater Cities comment on that just briefly and we will let you go ahead and finish your testimony.

Ms. **McKenzie**. Thank you so much, Mr. Chairman, very briefly, the council recommends that funding for the math/science field be targeted on districts with high need. So I guess we are closer to Mrs. Goldsmith's point of view, in that these decisions should be based on assessment and planning. So we believe in targeting to highest needs.

Chairman **Perkins**. Go ahead, finish your statement.

Ms. **Goldsmith**. Thank you, Mr. Chairman.

I forgot where I was. I think I was saying that rather than spread so thinly that every district would receive very little, we think it would be better if States could target the funds now for the districts most in need. This would not only promise better results, it would also permit much better coordination of the Federal aid with the State's own efforts.

Moreover, States are in the best position to pool funds for two or more districts. I would like to emphasize that if the bill were changed as we proposed, we would also urge that due consideration be given to the special needs of the disadvantaged, women, the handicapped, and language-minority students, and that this be required by statute or regulation.

The State boards of education are eager to do their part in this crucial national effort, and I would remind you that the States which have the constitutional responsibility for education have a remarkable record in meeting national emergencies.

During World War II, under the National Emergency Production Act, State Department of Education received more than $300 million from Washington, a far larger sum in those days, to train workers for defense-related industries.

Between 1940 and 1945, this emergency action produced an astonishing 7.5 million skilled workers, popularly symbolized by "Rosie the Riveter," and I know most of us remember her.

Mr. Chairman, on behalf of NASBE and the State boards of education, I want to thank you for the opportunity to be involved with you this morning. We think you have tackled a very crucial issue. It is clear that there are differences in how we fund it, but there are no differences in the understanding of the need for funding and to move ahead with the kind of legislation you propose.

Thank you so much.

[The attachment to Ms. Goldsmith's statement follows:]

[From the National Association of State Boards of Education]

ATTACHMENT

1. "Classroom Crisis in Science and Math," Paul DeHart Hurd, Professor of Education, Stanford University, Chemical and Engineering News, July 19, 1982: "Currently, for example, only 34 percent of U.S. high school graduates have completed three years of mathematics; only 8 percent have taken calculus, which is taught in only 31 percent of U.S. high schools. Fewer than 20 percent of the graduates have had three years of science. Most seniors have had a course in biology, but only 19 percent have had physics."

2. "Classroom Crisis in Science and Math," Sarah E. Klein, retiring president of the National Science Teachers Association, Chemical and Engineering News, July 19, 1982: "She cited a 1981 survey of state science supervisors by Trevor Howe and Jack Gerlovich of the University of Iowa Science Education Center. That survey, based on the response from 43 states, disclosed a 'critical shortage' of chemistry teachers in 10 states and a 'shortage' in 27. For physics and math teachers the situation was even worse."

3. "Math, Science Teachers Are in Short Supply; One Solution: Money," National Science Teachers Association, the Wall Street Journal, December 21, 1982: "According to the National Science Teachers Association, 43 states reported shortages of math teachers, 42 were short of physics teachers and 25 percent of the math and science teachers surveyed by the association said they were planning to leave teaching for better paying jobs in industry."

4. Education USA, January 10, 1083, report from the National Academy of Science/National Academy of Engineering: "The academic preparation of science and math teachers typically does not include the courses they need to do a good job of teaching in high school. University science departments and schools of education must recognize their responsibility in reforming teacher education."

5. Education USA, January 10, 1983, report from the National Science Foundation:

"Most teachers are dissatified with community attitudes, treatment of education by the media, student attitudes toward learning and status;

"About 67 percent of the teachers said they needed help in getting information about new instructional materials, but only half received any assistance. Maintenance of equipment was the most frequently cited (60 percent) need;

"Availability of lab assistants or paraprofessionals and money to buy supplies were seen as major needs;

"Math teachers said the lack of materials for individualizing instruction was their largest problem;

"Science teachers perceived three serious problems: inadequate facilities, not enough funds to buy equipment and supplies, and a scarcity of materials for individualizing instruction; and

"Only 22 percent of elementary school teachers feel "very well qualified" to teach science, and 16 percent feel "not well qualified." Sixty percent feel "adequately qualified." "

6. American Federation of Teachers Preliminary Report on the Math/Science Teacher Shortage. "The number of newly issued certificates being issued in New York State are going down dramatically. For example, between 1975 and 1979, the number of newly issued certificates declined by the following percentages: Math—69 percent, Biology—48 percent, Chemistry—54 percent; Physics—50 percent, and Earth Sciences—49 percent."

7. "A Summary Report on the Educational Systems of the United States and the Soviet Union: Comparative Analysis," Catherine P. Ailes, Francis W. Rushing, National Science Foundation, February, 1982: "Science and the development of critical thinking skills in social studies and math have assumed a low priority in the thinking of school administrators. An increased emphasis on the basic learning skills, such as reading, arithmatic, and spelling, is preempting time previously available for the study of science, social studies, and mathematical concepts, especially in elementary schools. The NSF case studies observers found that in most schools natural sciences, mathematics, and social science inquiry were seen as having a rather limited value for the student body at large, and that providing a strong K-12 program

in science for those students who will become the nation's future scientists was not a high priority in most of the school systems."

8. Mathematics Teacher, March 1981: "More than 5,000 of the school's districts have "no certified math or science teacher at a time when we are emphasizing those subjects." The same article reports that Dallas had 150 current vacancies, most of which were in math, science, industrial arts, and special education at the secondary level."

9. "The State of School Science." The National Research Council, June 1979: "The Soviet secondary school curriculum is quite accelerated in science and math as compared to U.S. high schools. The entire school population is exposed to the math-science oriented curriculum in Soviet secondary schools rather than only selected students as is the case in the United States. Thus, in general, the Soviet secondary school graduate has a far better training in math and science than does his U.S. counterpart."

10. "Education for a High Technology Economy," Material prepared for National Governors' Annual Meeting, August 8–10, 1982, by the Education Commission of the States:

"Between 1960 and 1977, the proportion of public high school students enrolled in science and mathematics courses declined; the number of students enrolled in science declined from 60 to 48 percent;

"Despite recent increases in mathematics and computer science enrollments, one half of all high school graduates in the U.S. take no mathematics or science beyond the tenth grade;

"Mathematics and science achievement, as measured by successive national assessments thrughout the 1970's have shown a steady decline. This decline has been least for 9 and 13-year-old age groups with increasing deficits for 17-year-olds;

"The effect of insufficient quality of mathematics and science preparation in the elementary and secondary schools is revealed by the fact that remedial mathematics enrollments at 4 year institutions of higher education increased 72 percent between 1975 and 1980—compared to a 7 percent increase in total student enrollments for the same period; and

"Scores on the Scholastic Aptitude Test (SAT) for approximately one million college-bound students have declined over an 18-year period through 1980. The mean score in mathematics dropped from 502 in 1963 to 466 in 1980."

11. "Education for a High Technology Economy", material prepared for the National Governors' Annual Meeting, August 8–10, 1982, by the Education Commission of the States. Material cites a deficiency in the math and science areas due to lack of educational goals among various state education agencies and negative attitudes of students. This is highlighted by the following data:

"Admission requirements for postsecondary institutions have generally reduced the number of years of pre-college mathematics and science instruction;

"By the end of the third grade, nearly 50 percent of students would like to take more science; by the eighth grade, only 20 percent have a positive attitude toward science;

"Time devoted to academic activities is closely correlated with achievement. The typical school year in the United States is 180 days, with students attending 5½ to 6 hours each day. The average number of days of school attendance is 161 because of absenteeism. This compares with a 240-day school year with 6 to 8 hours per day, in the USSR, China, East Germany, and Japan where absence from school is minimal;

"Students who report doing the most homework scored higher on the national assessment in mathematics; those students who report not doing homework and watching television scored lower in mathematics; and

"Although 21 states have established or are considering mandates for computer literacy and the application of technology for improving instruction, the barriers of the cost of hardware procurement, the cost and lack of availability of qualify courseware and the lack of trained teachers makes the implementation of this goal a long-term, difficult process."

12. Sarah E. Klein, President of the National Science Teachers Association, Testimony before the Senate Committee on Labor and Human Resources, 1982: "Only 55 percent of the graduates prepared to teach mathematics actually entered the teaching profession. Almost five times more science and mathematics teachers left teaching in 1980 for employment in nonteaching jobs than left due to retirement. If the present exodus of qualified science and mathematics teachers from secondary schools continues, the nation will have a net loss of 35 percent by 1992. The declines in qualified science and mathematics teachers have already exceeded enrollement declines by a factor of three."

13. Ronald Reagan, at the Convocation of the National Academy of Science and the National Academy of Engineering, May 1982, was quoted by the National Council of Teachers of Mathematics Fact Sheet: "The problems today in elementary and secondary school science and mathematics education are serious enough to compromise America's future ability to develop and advance our traditional industrial base to compete in international marketplaces. Failure to remain at the industrial forefront results in direct harm to our American economy and standard of living."

14. Education Week, 31 March 1982: "Since 1972 there has been a 77 percent decline in the number of secondary level mathematics teachers prepared in 600 teacher-training programs nationwide. Among newly employed science and mathematics teachers, 50.2 percent were judged by principals to be unqualified to teach in those fields, but had been employed on an emergency basis because school officials could not find qualified teachers. In the Pacific states, the ratings of unqualified personnel jumps to 84 percent by the principals."

15. "New Study Shows Decline in Math, Science Levels," Detroit, Michigan News, November 14, 1982, quote by Fletcher Byron, Chairman of the Board of Trustees of the Committee for Economic Development: "While the need for scientific and technical skills is growing, many studies now indicate the general level of scientific knowledge in this country is at an all time low."

16. U.S. News & World Report, 15 February 1982: "Alleviating the math-teacher shortage is one of the most immediate and pressing tasks facing colleges and and school systems."

17. National Science Teachers Association, 1981: "The quality of science and mathematics instruction is deteriorating further as a result of budget cuts. Sixty percent of science teachers have had their budgets for supplies and equipment cut, at a time when school labs are already obsolete and when computers and other modern electronics are essential to an up-to-date curriculum."

18. "Education for a High Technology Economy," Material Prepared for the National Governors' Association Meeting, August 8–10, 1982 by the Education Commission of the States:

"In the period 1971–1980, a survey of 600 colleges and universities with teacher training programs revealed that there was a 64 percent decline in the number of secondary school science teachers being prepared and a 78 percent drop for mathematics teachers;

"Twenty-six percent of all mathematics positions are filled by teachers who are not certified, or are only temporarily certified, to teach mathematics. This pool appears to be expanding, for among the newly-employed secondary mathematics and science teachers, 50 percent are uncertified to teach science or mathematics;

"Of elementary school teachers, 51 percent report they received no undergraduate training in science;

"Not only is there a shortage of qualified science and mathematics teachers, there is also a shortage of summer institute and college programs to educate them. The extensive programs of the National Science Foundation during the 1960's for the retraining of teachers after college no longer exists;

"The average salary of beginning mathematics teachers with a bachelor's degree is now only 60 percent of the beginning salary offered by private industry to bachelor degree candidates in mathematics and statistics; and

"High school seniors specifically bound for teacher education programs scored, on the averare, 48 points below the national average in mathematics skills and 35 points below in verbal skills on the Scholastic Aptitude Test (SAT)."

Chairman PERKINS. Thank you very much.

Ms. Knox, we will now hear from you, Director, Project on Equal Education Rights. Go ahead.

STATEMENT OF HOLLY KNOX, DIRECTOR, PROJECT ON EQUAL EDUCATION RIGHTS, ACCOMPANIED BY PAMELA SURKO, PRESIDENT-ELECT, ASSOCIATION FOR WOMEN IN SCIENCE

Ms. KNOX. Good morning. I represent the Project on Equal Education Rights of the NOW Legal Defense and Education Fund and several other organizations this morning, the American Association for University Women, the Association for Women in Science, the Women's Equity Action League and Wider Opportunities for Women.

I would like to pick up on the theme that has already been sounded by the last two witnesses, which is the need to bring women and minority males into technological fields that they are now drastically underrepresented.

There has been considerable testimony about the shortages we already have in computer fields, in engineering, in the physical sciences. Those shortages are getting increasingly serious.

Where are our future skilled people power going to come from? With the drop in the birth rates since the postwar baby boom, we have a much smaller pool of workers to fill those jobs. We are going to have to bring more and more women and minority males into technological fields if we are going to meet America's needs.

The growth of technology poses a particularly challenging situation for America's women and for the young women who are now in school. First of all, women are now dramatically underrepresented in technical fields, there are only 1 out of 100 engineers, there are 13 percent of the workers in math and computer and physical science fields.

The fields in which women are now concentrated are undergoing rapid technological change. Many women workers will be displaced over the next decade because jobs such as bank tellers, secretaries, and telephone operators are being automated so the traditional fields that women have gone into are shrinking and will be shrinking drastically over the next decade.

You can see the roots of the underrepresentation of women in the education system today. We are seeing that girls have a much greater tendency to avoid advanced math and science courses than their male peers.

For example, 4 out of every 10 girls going to college drop out before taking 4 years of math. Let me correct that, 6 out of 10 never get to the 4th year of math in the high school.

Our Michigan PEER project has been looking carefully at the arrangement of boys and girls in math and science courses in Michigan and I would like to insert the results of that study into the record.

Chairman **PERKINS**. Without objection, go ahead. Summarize it in about one-half a minute.

[The Michigan PEER math report follows:]

ED 027013-3

MICHIGAN PEER

Math Report

Published by The Michigan Project on Equal Education Rights • A Project of the NOW Legal Defense and Education Fund

PEER STUDY SUMMARY

Too few students in Michigan schools are receiving the math education they need to prepare for the high technology society of the future. Without the math they need, the options and opportunities of thousands of school children are automatically limited and the impact is particularly hard on girls.

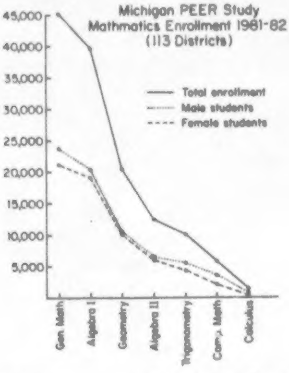
The most disturbing findings of the study of math participation in 113 Michigan school districts revealed:

There is a precipitous drop in math enrollments of over 50% after students have completed Algebra I, usually in the 9th grade.

By the twelfth grade only 36% of the girls and 45% of the boys are taking math, and not all of these students are in advanced math courses.

The smaller the district the smaller the proportion of students in advanced math courses.

These patterns of decreased math participation were consistent throughout the study.



Too few students are getting the high school math they need. Girls are not completing math sequences at the same level as are boys in Michigan schools.

MATH OPENS DOORS TO JOBS

How well will our children be prepared for the world of robotics, biotechnology, and telecommunications slated for Michigan's future?

Math-related jobs in technical, scientific and business areas will experience the most growth in the 1980's nationwide.

- Jobs for engineers, life scientists, data processing personnel, and business managers will increase by 25% to 54%.
- Clerical and sales jobs are undergoing rapid technological change in areas such as checkout systems, inventory control, and quality control.
- By 1990 over 1.5 million workers will be needed to instruct computers according to one labor forecast.

The worker who is comfortable with math and the new semiconductor based technology will be in increasing demand.

Computer Math

The gender gap was widest in Computer Math, or Computer Science as it is also called. The gap was 28 points.

PEER's study found Computer Math is expanding rapidly with more students in Computer Math than in Calculus.

- About half of the 113 districts in the study offered Computer Math.
- Almost all districts (89%) with over 4000 students offered Computer Math.
- Only 32% of the districts under 4000 students offered Computer Math.
- Girls were only 36% of the Computer Math participants.

Two districts in the study were far ahead in student enrollment in computers: Birmingham (1108 students) and Grosse Pointe (673 students). Girls were only 35% and 34% of those programs respectively.

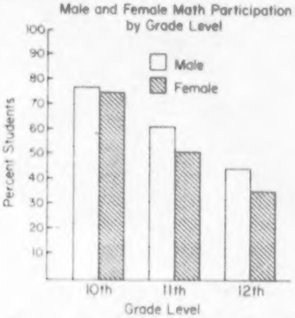
The seeming computer shyness on the part of girls is not consistent with young women's enrollments in computer-related vocational classes. Girls make up 59% of the Business Data Processing Classes and 60% of the Computer Operations classes. However these computer classes are located in Office vocational programs, which culturally carry a female stereotype while math seems to carry a male stereotype.

The outcome of this stereotyping in schools is that students in computer vocational classes are channeled into lower paying jobs while computer math students strenghten their options to find jobs in higher paying fields.

THE GENDER GAP IN MATH

The data which most dramatically showed the difference in math education of girls and boys was the mathematics enrollment data given by grade level.

For the 80 districts supplying grade level enrollment data we found only 51% of the 11th grade girls and 36% of the 12th grade girls taking math, as compared to 61% of the 11th grade boys and 45% of the 12th grade boys. These figures do not take into account the level of difficulty of the math class taken.


Male and Female Math Participation by Grade Level

The drop in female participation in advanced math courses exists regardless of the size of the district, though there were variations among districts. In Computer Math we found, for example:

District	Total Students	% Female
Farmington	154	47%
Jenison	85	47%
Ann Arbor	172	23%
Trenton	72	22%

Proportionately girls were 48% of the Algebra II students, but we saw imbalance as wide as 80%/20% in some districts.

The fact that many districts are doing well holds out the hope that with some effort the gender gap can be closed in all districts as we strive to improve the participation of all students in math.

WHY LIMIT OPTIONS?

Research over the last decade has disproved many commonly held assumptions that serve to limit girls' options. We now know for example:

Girls need math.

Nine out of 10 high school girls will need to work (an average of 25 years) yet lower pay and job status for women of all cultures, and particularly for ethnic minority women, is a worsening fact of life.

If young women shy away from the more advanced courses, they are shut off from careers in such fields as accounting, medicine, engineering, computers and the sciences.

Girls are good in math.

The results of the Michigan Educational Assessment Program over the past five years show females consistently higher than males in both math and reading at all testing levels (4th, 7th, and 10th grades).

Girls like math.

Two recent studies found similar results: there is no difference in math preference between girls and boys and there is nothing intrinsic in mathematics that makes it more appealing or enjoyable to one sex than to the other.

The existence of role models to encourage young people can also be important, yet with quota-like stability only 35% of the math teachers and 21% of the science teachers are women according to state data.

Recent studies also tells us the role of the father, his expectations and encouragement, plays a large role in determining a daughter's or son's participation in math and choice of math-related career.

Clearly to get at the problem of declining math enrollments we must increase the participation of both girls and boys in advanced math programs.

STUDY FINDINGS BY COURSE AREA

Most districts require math in the 8th and 9th grade so students usually take General Math and Algebra I. The decrease in math enrollments is in part due to the one year high school math requirement in most districts and low college entrance requirements.

The study findings by major course areas, in the order they are taken, showed:

- Slightly fewer girls, 47%, than boys were in the General Math courses.

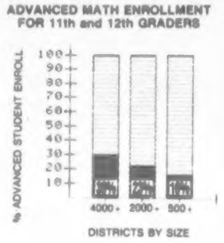
  At this course level only 6% of either boys or girls take consumer or business math, refuting the notion that girls are not in advanced math because they start off in other math sequences.
- A major drop occurs in the number of students enrolled in Geometry, just 65% of the Algebra I enrollments.
- Algebra II enrollments were only one third the number of students in Algebra I.
- Senior courses in Trigonometry (including analytic geometry and precalculus) were 43% female.
- Calculus was offered in only one third of the districts and was only 40% female, a gender gap of 20 points.

Declining Enrollment by District Size

The problem of decreased math enrollment was further clarified when 11th and 12th grade enrollments were examined for Algebra II, Trigonometry, Computer Math and Calculus.

Smaller districts offer fewer advanced math opportunities.

While the larger districts had a greater percentage of students taking math the patterns of decreased math enrollment remained the same.


ADVANCED MATH ENROLLMENT FOR 11th and 12th GRADERS

STUDY RECOMMENDATIONS

We hope this citizen-initiated effort will raise the awareness of educators of the need for better math preparation in our elementary and secondary schools and will demonstrate our concern and our support for the following actions:

1. Math requirements for high school graduation must be upgraded.

2. Students should be actively recruited into advanced math courses with care given to ensuring the participation of female students.

3. The Department of Education and local school districts should collect, analyze and report math participation data by course grade level, sex and race annually.

HOW YOU CAN HELP

You can be influential in helping the student of today learn math skills. A recent study of factors affecting women's participation in mathematics indicates they are similar for both girls and boys. Factors, ranked in order, are these:

- Knowing how math will be useful.
- How well students do in math and how much they like it.
- What math teachers and parents think.
- What the school counselor thinks.
- Whether friends take math and whether classmates approve.

These factors and the above recommendations can help us develop strategies for increasing math participation of all students. More detailed ideas and suggestions are available in the resources listed below.

Compilation of the Report

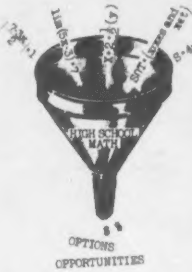
The data for the study was collected by the American Association of University Women with help from the Church Women United and voluntary submission of the data from local school districts in response to a request in PEER's newsletter "Michigan PEER Perspective."

The form used was developed by the National Council of Teacher's of Math and is available from the Council or PEER.

The total number of districts in the study was 113. Of these districts, 80 were able to provide both enrollment data by grade level and course as well as by sex.

The state Department of Education has confirmed that the study's 80 districts constituted a valid sample of the state.

Copies of the 12 page analysis of 1981-82 data, prepared by Michigan PEER's director, is available for $2.00 from Michigan PEER.



"Why limit your choices? Math opens doors to jobs."

● High school algebra and geometry are needed for many technical jobs not requiring a college degree. ● Four full years of high school math are needed to survive in first year calculus. ● "Hard" calculus college sequences are needed for careers in the sciences and engineering. ● "Soft" calculus college sequences are needed for careers in business, management and economics.

MATH AND SCIENCE RESOURCES

Achievement and Participation of Women in Mathematics: An Overview. Jane M. Armstrong. 1980. An update on the participation of girls in high school math. Suggests ways to improve girls' math achievement. Education Commission of the States. 1860 Lincoln St., Suite 799 Denver, CO 80295. 35 pp. Free.

Are Girls Too Facho For Math?* Michigan Project on Equal Education Rights. Math opens doors to jobs, says this eye-catching 11" x 17" poster. (*Rhymes with macho.) PEER 211 East Commerce, Milford, MI 48042. $1.00, single copies, $.75 multiple copies. Prepaid.

Expanding Your Horizons in Science and Mathematics. Joanne Koltnow. 1980. How to plan, conduct and evaluate conferences to increase young women's interest in math and science. Education Development Center, 55 Chapel St., Newton, MA 02160. 44pp. $2.50.

Helping Able Young Women Take Math and Science Seriously in Schools. Patricia Lund Casserly. 1979. Reprinted from New Voices in Counseling the Gifted. Has recommendations for helping gifted girls achieve their full potential in math and science. For parents, teachers and administrators. College Board Publications Orders, Box 2815, Princeton, NJ 08540. 15pp. Free.

Overcoming Math Anxiety. Sheila Tobias. 1978. Explores the causes and consequences of math avoidance, particularly among girls and women. Offers some suggestions for conquering it. W. W. Norton & Co., 500 Fifth Avenue, New York, NY 10036. 278pp. $12.95.

The Problems of Woman and Mathematics. Lynn H. Fox. 1980. Explains factors influencing the study and learning of math and has suggestions for remediation, intervention, prevention of sex-typing in math. The Ford Foundation, 320 East 43rd Street, NY, NY 10017. 40pp.

Use EQUALS to Promote the Participation of Women in Mathematics. Alice Kaseberg, Nancy Kreinberg, Diane Downie. 1980. For administrators and teachers. A model workshop on math avoidance problems. Shows teachers how to involve students in math through enjoyable non-threatening games, problems and activities. Lawrence Hall of Science, University of California, Berkley, CA 94720. Att.: EQUALS. 134pp. $5.00. Prepaid.

Michigan PEER's Math Report. Elizabeth H. Giese. 1982. Summary of Michigan high school math study. PEER, 211 E. Commerce, Milford, MI 48042. $1.00 single copies, $.75 multiple copies. 4pp. Prepaid.

Ms. Knox. What we have found is very interesting—we found that in computer science courses, out of 113 school districts, girls are outnumbered 2 to 1 by boys.

In calculus and trigonometry courses, boys substantially outnumber girls. We have also found that the numbers, the percentage of girls, vary a lot from school district to school district which suggests that things that the school district are doing and can do can make a difference.

We found, for example, that in some school districts, girls are outnumbered 4 to 1 by boys in computer science classes and in trigonometry classes. In other school districts, the numbers are about equal.

We have also seen over the last few years that you really can make a difference in course taking and other educational attainment of girls by encouraging them through teachers and parents. Parents are critical.

A recent study has demonstrated that the single most influential factor in the math and science courses girls take are fathers, their father's expectations. So parents, particularly fathers, are very powerful influences on the courses that their daughters will take.

We have also found that teachers can make an enormous difference, and in one Michigan school district where PEER volunteers raised this issue to a level of consciousness, both among parents and teachers, and teachers started talking to young women about why they needed to take advanced science and math courses, they made a dramatic difference in the enrollment, not only of girls, but of boys.

In one high school, those efforts resulted in increasing physics classes from 2 to 5 in 1 year. So we know that we can make a difference.

Our recommendations for this legislation, first of all, I want to say that all of the organizations I represent this bill and commend your leadership in bringing this issue forward. We also are concerned that the bill needs to build in provisions which deal with the particular barriers that women and minority males experience in going into these fields.

If we do not do that, everything that we do here through this legislation will continue to increase the gap between white males and the rest of the population. So we suggest a number of provisions.

For instance, in teacher training, vital, we suggest that provisions be built in that make sure that in all of the teacher training efforts funded under this bill, we train teachers to reach out to those special populations.

There are already effective training programs that do that and those techniques can be built into teacher training under this bill. We also recommend strongly that you build in provisions to involve parents in all aspects of these programs for several reasons. One is because of their powerful influence on the behavior of their own kids. We need to educate them and get them involved.

Two, we need broad community support for the measures that school districts are going to have to undertake now to strengthen science and math education. We have got to involve parents in those efforts in order to build that broad kind of community support.

And parents are already beginning to lead the demand for computers in schools for more technical education for their kids. They are an enormous resource and that needs to be recognized in the legislation.

We also recommend that you build in incentives to school districts which succeed in increasing the percentage of young women and minority males in advanced science and math courses that can actually show that they are increasing those numbers.

Finally, we recommend that you build in national development and dissemination into this program. Clearly, there will be developing a lot of interesting programs at the local level through dispersing money to the school districts. The best of those need to be picked up and disseminated around the country so we do not have 16,000 school districts inventing the wheel for themselves.

Also, there are already some very effective programs that need to be disseminated nationally, some things that work, have been shown to work in individual school districts or States that could be used around the country. This bill needs to recognize that.

And finally, there are new and emerging problems in which we have developed very little effective intervention techniques. An example are the computer science courses which are so new we are just beginning to deal with the problems that women and minority males have in those fields. We are seeing that there is a real difference in seeking of those courses among women and minority males, but there has been very little developed to address that problem, so we also need national development to deal with some of the emerging issues.

Finally, we recommend that throughout the bill that there be an awareness built in that it is going to be critical to address the needs of those underrepresented populations.

Thank you.

[Prepared statement of Holly Knox follows:]

PREPARED STATEMENT OF HOLLY KNOX, DIRECTOR, PROJECT ON EQUAL EDUCATION RIGHTS

Good morning Mr. Chairman and members of the Subcommittee. My name is Holly Knox. I am the director of the Project on Equal Education Rights of the NOW Legal Defense and Education Fund. With me is Dr. Pamela Surko, president-elect of the Association for Women in Science. In addition to PEER and AWIS, I am also representing the American Association for University Women, Wider Opportunities for Women and the Women's Equity Action League.

These groups all share a grave concern about the quality of math and science education. We are all grapppling with the same problems: How can we ensure that our educational system adequately prepares all children for a future in which math and science knowledge will be essential tools for success in the workplace? And how do we guarantee that traditionally-underrepresented groups, such as women and minority males, are not locked out of tomorrow's workforce because they lack a background in math and science?

I would like to begin by saying that we support H.R. 30. Legislation aimed at upgrading math and science education is critical and we commend you for taking leadership on this issue. We would like to share with you our views on the legislation and offer a few suggestions about how it could be improved.

Never before in history has there been such a great need for persons skilled in mathematics and science. Yet our educational system is singularly ill-equipped to serve this need at the present time. For example, there has ben a drop in mathematics and science course-taking over the last two decades—between 1960 and 1977, the proportion of public high school students enrolled in science courses declined from 60 to 48 percent. There has been a parallel drop in achievement—math

SAT scores for college-bound students have declined steadily over the last 18 years through 1980 and only recently has this trend begun to reverse itself. The National Science Board Commission on Pre-College Education in Mathematics, Science and Technology reports that in 1981, 50 percent of teachers newly employed nationwide to teach secondary science and mathematics were actually uncertified to teach those subjects.

Experts predict critical shortages in the fields of engineering, computer science, mathematics and the physical sciences. According to the Bureau of Labor Statistics, there will be a shortage of over half a million computer operators, systems analysts and technicians by 1990. The National Engineering Manpower Project of the Electronic Industries Association predicts that the demand for electrical and computer engineers will exceed supply by almost 40,000 by 1985.

Yet the absolute number of high school graduates in 1985 will be 15 percent lower than in 1975, according to the Southern Regional Education Board. Where will the high technology workers come from? Given that the majority of workers—60 percent—are women and minority males, it is clear that any substantial increase in high technology workers will emerge from the very groups that have historically been underrepresented in math and science fields.

The National Science Board Commission in their report, "Today's Problems, Tomorrow's Crises," stated that "to meet the country's needs for excellence, creativity, and innovation in its scientific work, we must develop and utilize the talents of all Americans, particularly women and minorities, now currently underrepresented in the science and engineering professions."

Dr. Cora Marrett, the Chair of the National Science Foundation's Committee on Equal Opportunity, couched the problem in even more urgent terms during the December meeting of the National Science Board Commission. "(W)ithout access, without equality of opportunities, the very health of the scientific enterprise of this nation is threatened and the health of the nation in general . . . (T)he focus of the problems of access of the underrepresented is a focus on enhancing the scientific manpower of the nation."

In fact, the very jobs that are increasing the fastest are the very jobs where women have not been employed. Jobs like machine mechanic, computer systems analyst, computer operator and computer programmer are among the Department of Labor's list of the 30 most rapidly increasing occupations for the 1980's. In the critical field of computer science, women have consistently been underrepresented. In 1976, while women were 40 percent of the labor force they held only 13 percent of the jobs in math, computer and life science. Women have historically been missing from other expanding career fields; in 1976 women held only 7.5 percent of the jobs in the physical sciences and one percent of the jobs in engineering.

Judging from the educational programs that prepare future professionals in these fields, women are likely to stay substantially underrepresented in scientific and technical fields. While the trend has been slightly upward over the last decade, young women are still enrolling in education for these fields in dramatically smaller numbers than men. For example, in 1965, women earned only 22 percent of bachelors degrees in science and engineering. By 1981, the proportion had increased to 37 percent. In 1970, only 14 percent of all college graduates specializing in computer and information sciences were women. In 1980, 30 percent of these graduates were women. There have been modest recent gains, but women are still a small minority in educational programs in these fields.

At the same time, traditionally-female occupations are undergoing enormous change. An estimated 80 percent of working women are now concentrated in occupations which are rapidly declining or becoming obsolete as a result of technological advances. Jobs such as bank teller, telephone operator and clerical worker are undergoing major changes which will result in dramatically fewer jobs available in fields in which women have traditionally been concentrated. This revolutionary change in the nation's labor market will have a devastating impact on women. Not only will women face job displacement, but they also will face long-term or even permament unemployment because few will have the resources or opportunity to acquire the necessary skills to enter and advance in the technical job market.

SPECIAL BARRIERS FOR YOUNG WOMEN

Perhaps the greatest barrier to the achievement and participation of young women in mathematics and science is the persistent cultural bias that these fields are properly in the male domain. The consequences of this perception are severe.

In 1972, sociologist Lucy Sells conducted a systematic study using a random sample of freshmen admitted to Berkeley that fall. She found that 57 percent of the boys but only 8 percent of the girls had taken four full years of high school math. The situation had changed in 1981. In that year, one-half of college-bound girls compared to two-thirds of college-bound boys had completed four years of high school math. Despite this improvement, the gap in enrollments, especially in advanced courses, persists.

PEER's own study of math enrollments in 113 school districts in Michigan in the fall of 1981 confirmed this pattern. Boys outnumbered girls two to one in computer math courses; in one school district the percentage of girls in computer math was as low as 22 percent. Girls were 40 percent of the students in calculus and 43 percent of the students in trigonometry. We also found advanced science courses with enrollments as low as 19 percent female.

This difference in course-taking is chiefly responsible for the lower achievement rates of girls that many studies have reported. While boys and girls tend to do equally well in math at elementary school levels, girls' math scores drop behind in junior high and fall further behind at the high school and college level. These findings are consistent across numerous studies including those of the National Assessment of Educational Progress and the SAT.

There has been a great deal of research undertaken in the last decade aimed at understanding what factors influence students' choices concerning math and science education. Much of the research points to two key groups as powerful influences on young people's career choices: parents and teachers.

A 1980 study funded by the National Institute of Education to look at what factors influence the achievement and participation of women in mathematics turned up some interesting insights as to why children of both sexes choose to take math courses. The study found that three most important considerations that go into the decision to take math are:

Positive attitudes toward mathematics;

Perceived need for mathematics for future career and educational plans; and

Influence of significant others, including parents, teachers and counselors.

Parental encouragement and support is important for both boys and girls, according to the study. The best predictor of what courses girls would take was their perception of their father's educational expectations. In general, the study leads to the conclusion that girls receive less encouragement than boys, have less positive attitudes towards math and see math as less useful for their future careers.

Teachers also play a pivotal role in a girl's choice to pursue math. In her paper, "Mathematics Education Research: Implications for the 80's," Dr. Elizabeth Fennema points out some ways that teacher behavior can have the unintended effect of discouraging girls from taking math classes. Some teachers—but not all—have higher expectations and demand more from boys than girls. Teachers interact, both positively and negatively, more with boys than girls. Teachers ask more questions and more difficult questions of boys than girls. Other research has shown that these differences in teacher behavior are more extreme with high ability children.

On the other hand, teachers can have a tremendous positive influence. Many women who have become successful in scientific fields report that it was the influence and encouragement of a single teacher that made the difference. Such things as exposure to same-sex role models, sincere praise for a job well done, and advice on the value of math and science for future careers, all tend to make a big impact on girls' choices, according to research.

PROGRAMS THAT WORK

Over the last 15 years, intervention programs have been developed aimed at removing some of these barriers to achievement. In 1980, the American Association for the Advancement of Science prepared an inventory of programs for women and girls in math and science between 1966 and 1978. They found 315. Intervention programs for minorities include the National Association of Pre-College Directors, a network of 14 programs aimed at increasing minority participation in math, science and engineering. These programs pursue a variety of intervention strategies, including career awareness programs, inservice training for teachers and administrators, parental involvement and remediation of students. The striking thing about many of these programs is that they work—and they are often inexpensive to implement. Some examples include:

EQUALS.—Located at the Lawrence Hall of Science in Berkeley, California, EQUALS is a low-cost training program designed to provide practical assistance to teachers, counselors and administrators, serving grades K-12. Since 1977, 2,000 educators in California and 2,000 educators in 25 other states have participated in the EQUALS program. Evaluations show that in schools where the EQUALS program has been used for two or more years, there is an increased participation of girls in advanced math class, and the students of EQUALS teachers (both boys and girls) have improved attitudes towards mathematics and increased interest in mathematics-related career fields.

Mathematics, engineering, science achievement (MESA).—Since it began in 1970, MESA has delivered a variety of educational services aimed at stimulating enrollments and success of minority students in college preparatory high schools in California. Approximately 500 MESA students now graduate per year with the educational background they need to succeed in mathematics, engineering and the physical sciences. More than two-thirds of MESA's graduates select math-based majors in college

Career oriented modules to explore topic in sicence (COMETS). The COMETS project at the University of Kansas focuses on using role models to encourage science career interests among female high school students. Each of 24 lessons describes science activities which role models can use to arouse interest in a particular science concept and to explain how the science concept is applied in her career field.

PEER community campaigns.—PEER is currently working with community groups in four states in an effort to improve access to quality education, particularly in the math and science area. Reports from the Michigan project, PEER's longest running project, demonstrates the kind of impact community involvement can have at the local level. The increased community awareness of the importance of math and sicence education to girls' futures has resulted in concrete changes. Citizens interest generated a pioneering study of math enrollments, now being used extrensively by Michigan's teachers, administrators and parents. Community groups in two towns have initiated programs aimed at improving attitudes and increasing awareness among both teachers and students concerning math and science education as a result of the study. Educators, having perceived the need to make changes, use community interest and involvement in the study as evidence that parents support these changes.

One significant effect of these programs is that they benefit boys as well as girls. Programs focused on career awareness can capture the interests of both sexes. Both boys and girls can benefit from programs to reduce math anxiety and avoidance. The EQUALS program equips their participants with creative, imaginative and fun ways to teach mathematics—techniques that will stimulate boys as well as girls. One Michigan high school teacher reported that when, as a result of the Michigan project, the school started encouraging girls to take physics, they got more boys too. They increased the number of physics classes from two to five. The result of these intervention programs offer solid support for Dr. Marrett's statement that "It is to our advantage to start with segments that seem to have the greatest problems, because if we can solve those, we can solve anything."

IMPLICATIONS FOR THE "EMERGENCY MATHEMATICS AND SCIENCE ACT"

Teacher training.—Given that there are differentials in the educational experience of boys and girls, any inservice training must include components that help teachers reach out to and involve women and minority males. Awareness is key. School administrators, school board members, counselors and teachers all need basic awareness training about the special barriers women and girls encounter in math and science education. We recommend that the techniqes and models already pioneered and proven in successfull intervention program be incorporated into inservice training and retraining. Both boys and girls would benefit.

Teacher retraining is a short-term solution to two problems: an oversupply of English and humanities teachers and the shortage of math and science teachers. But teacher training should be of high quality and intensive. These teachers need to be motivators as well as instructors; they cannot motivate without a strong background in their fields.

In addition, there should be some effort made to recruit part-time teachers, retired teachers and teachers who have left the teaching field and want to return for retraining and certification.

Involement of groups outside the formal education system.—Many successful intervention programs, such as EQUALS, are located outside the formal educational system. More emphasis should be put on involving and supporting local programs that have already developed some solutions to the problem, particularly in the area of involving girls and women in math and science programs. It is particularly important that the "Summer Institute" section of the proposed legislation be broadened to include non-profit and community groups as possible recipients.

Parental involvement.—As I have said before, parents are a key group. Because parents have such a great influence on their children's career choices, it is critical that parents become aware of the problem and if possible become involved in the solution. One of the purposes of local funds should be developing parent-school partnership programs.

Incentives.—A basic weakness of this bill is that there is no built-in incentive for schools to actually improve the quality of education—and there is no way of tracking how well the law has fulfilled its purposes. We recommend that some method of tracking and evaluating the implementation of the law be incorporated into the bill. In addition, since increasing the participation of women and minority males in math and science programs is key to increasing participation in general, we recommed that incentives be given in the second year to schools that can show increased participation of women and minority males in their math and science programs.

The need for a national effort.—We are concerned that there is no funding for national level development, dissemination and evaluation of materials and model programs. In fact, this kind of centralized effort is sorely needed. Too often local school districts operate in isolation and are unaware of what resources are available. There are scores of programs already in existence with proven track records but they are not widely known. It is duplicative, costly and inefficient to have some 16,000 school districts all inventing some version of the wheel.

As I have mentioned, there are many fine intervention programs already in existence. But rapid technological and societal change mandates a continued commitment to developing new programs to help solve those problems that are just beginning to surface—such as inequities in microcomputer use in schools.

Curriculum development.—Existing science and mathematics texts often omit and stereotype women and girls. For example, the pronoun "he" might be used exclusively in word problems or the work problems themselves might describe traditionally-male activities that girls may be unfamiliar with or disinterested in. "Children, Television and Science: An Overview of the Formative Research for 3-2-1 Contact" produced by the Children's Television Workshop showed that girls preferred shows with female leads, that depicted relationships between people and that focused on animals. This give a clue to developing a science and math curriculum that interests both sexes, not just boys. At the very least, any curriculum that is developed for math and science classes or for computer use must be free of sex stereotyping and sex bias.

ENCOURAGING EDUCATION LINKAGE TO THE LABOR MARKET

Community-based employment organizations should be an allowable grantee under the Summer Institute program. Such groups have pioneered classroom training and other methods to quickly provide individuals with the math and science literacy they need to be competitive in the job market. These groups have demonstrated effectiveness (particularly in working with populations such as women, minorities, and the handicapped who are underrepresented in math/science-related occupations). They can develop Summer Institutes which (1) provide teacher training about the emerging technologies and changing labor market and (2) offer a series of occupation-specific math and science sessions for educators.

STATE EFFORTS

One of the uses of state funds should be to develop state-wide programs and strategies for increasing the participation of women and minority males in math and science courses.

RESEARCH AND DEVELOPMENT

The National Institute of Education has already done a fine job of funding research to identify the special barriers women face in math and science education. More research needs to be done on solutions. Additional research should explore the emerging issues involved with the growth of computerized instruction. Very little research has been done on equity in computer use, for example. Some anecdotal evidence suggests that boys may use computers in schools more than girls. This could have serious implications. We recommend that one of the priorities for research and development be investigating and finding solutions to those factors that might discourage women and minority males from pursuing math and science education.

CONCLUSION

The legislation is a good start toward improving the quality of math and science education but much more needs to be done. We expect, also, that the funding level that is proposed for this legislation will not be sufficient to accomplish all that needs to be done.

Opening the doors to math and science careers to women and minority males is not simply an issue of fairness and equity. Women and minority males are now the majority of our workforce. Unless we tap this pool of workers, shortages in skilled workers will only get more serious. Legislation aimed at improving math and science education must take into account the lower participation rates of women and minority males in these programs and take steps to ensure that our educational system better serves their needs. This is absolutely crucial.

Again, I commend you for taking leadership on this issue. Thank you for giving us the opportunity to share our views on this important piece of legislation.

Chairman PERKINS. Thank you very much for an excellent statement.

Mr. Charles Cooke, Federal programs coordinator, California Department of Education. We are glad to welcome you here. Go ahead.

STATEMENT OF CHARLES COOKE, FEDERAL PROGRAMS COORDINATOR, CALIFORNIA DEPARTMENT OF EDUCATION

Mr. COOKE. Thank you, Mr. Chairman.

I will attempt to summarize my testimony. We in California, of course, have a major problem with regard to science and math and computer teachers. We estimate that we are probably losing about 1,000 teachers a year, and it may be higher than that in the outgoing years.

We see the teacher supply problem as sort of in the three R's: as the retraining and upgrading of current teachers; the recruitment of new teachers; and the retention of the current teachers. I think this bill addresses somewhat the problems of retraining and upgrading and, to a lesser extent, the recruitment of new teachers. It does not really go into the problem of retention of current teachers and I will have a recommendation later for that effort.

The funds in the bill are extremely limited, given the size of the problem. Therefore, it would be our recommendation that there be some matching requirements in this bill. We would make recommendation that perhaps as high as 50 percent matching and that that matching should be State, local, and Federal dollars.

It seems to us to make sense that vocational education money, chapter I moneys, special education money which is being used to pay for teachers in the math and science areas, particularly mathematics, that those kinds of funds being devoted to those purposes could indeed serve as matching dollars for the dollars in this bill. We think both part A and part B should have a matching requirement.

In addition, we think, though, in a way what we are saying is you are making this a challenge grant; you are challenging school districts and States and institutions of higher education to find some more dollars and to help do this.

As I pointed out, we would recommend that you consider having the funds received from local businesses and industry tied to performance bonus. If the business and industries in the area contribute a significant amount of matching funds, that school district would receive perhaps a 10-percent bonus in this grant. This would provide, we think, a fairly heavy incentive to school districts to talk with and work with their local businesses and industry to get more money to deal with this problem.

We also think that you need to insure in the bill that you get high-quality inservice teacher training. In the State of California, we have in place, as a result of the initiatives last year, $19 million which has developed 16 science and technological centers throughout the State.

We believe that a regional approach to inservice training and the utilization of these regional teaching institutions or teacher training institutions and/or institutions of higher education, should be required in the bill for the money that school districts are going to expend.

We do not believe that it is necessarily good for single school districts to develop their own in-service training programs without regard to statewide standards and criteria. Therefore, we recommend that there be some tie in the legislation requiring that statewide standards and criteria are met in any in-service programs to which the district is going to dedicate its money.

Finally, I would say that even in the congressional scholars, you may be able to work an incentive thing there. Each Member of the House could be allowed more than two candidates if the business and industry located in their district donated half of the scholarship for an individual. For each half scholarship donated, another candidate could be nominated by the member.

We think that, again, could expand the size of that program and address the problem in a more—in a larger fashion.

Finally, I would recommend that to deal with the retention problem, that a fellowship program be authorized. A specific amount of funds, perhaps as high as 10 percent of the entire State grant, would be designated to go to the State board of education.

These funds would provide fellowships for secondary school teachers in math, science, and computers who had taught in the secondary schools for a minimum of 5 years. The fellowships would provide for tuition, per diem, and district substitution costs for a period of up to 10 weeks for upgrading in teaching skills and instructional techniques in science, math, and computers.

Upon successful completion of the 10-week course, the teacher would be given a certificate of graduation and become a member of the fellowship and a voucher or bonus of $2,000. That voucher of $2,000 can only go back to the district with the teacher and would be expended for the purposes of upgrading the instructional materials or the equipment in his or her classroom.

We think that would provide a significant incentive to teachers. We also think it would help in the retention and we think that it could have a positive effect on students making decisions to become teachers in these fields.

Finally, Mr. Chairman, having discussed some of the substantive issues of the bill, I regret I have to turn to a major difficulty with it, that we have with the bill, and that is the formula. We hope that the committee will be able to revise this formula to one that is significantly more equitable to those States with the largest student population and thus the likely major suppliers of science, math and computer-trained personnel.

I have attached a table to my testimony highlighting the problem. Many of the large industrial States do not receive their equitable share. California, in particular, receives significantly less than its share of the student population. New York, New Jersey, Connecticut, Massachusetts, Illinois, Pennsylvania, Colorado, Washington, and others are States that are shortchanged by this formula.

As usual, in formula fights, equity is defined by the eyes of the beholder. However, I believe it can be shown that the H.R. 30 formula, as currently written, is clearly inequitable. The attached table I have makes a comparison in terms of the percentage of school-age population, the gains and losses to each State, as a result of the formula that is currently in the bill, and also looks into how much each State gets in terms of its dollars for education from the Federal Government. Finally, the per capita State and local expenditures for the local schools, including capital outlays, in each of these States.

What the table basically shows you is that the H.R. 30 formula, as it currently exists, penalizes those States that have the highest cost of education, such as Alaska, New York, California, and others. It penalizes those States which receive the smaller shares of their educational funds from the Federal Government, and it penalizes those States which provide a greater-than-average per capita State and local expenditures for their schools.

Further, the formula clearly penalizes those States with the most severe unemployment problems, those States which are most in need of major retraining and upgrading to retool their work forces. And those States which have the larger number of high-technology industries most in need of science, mathematics, and computer professionals.

We believe the formula must be revised, Mr. Chairman, and we would suggest that you look at——

Chairman PERKINS. One of the reasons we had enacted Federal legislation all through the years—when I came to Congress in 1949 and 1950, all the good teachers in my State went to California and everywhere else. That was the problem that brought on this situation, trying to hold some of these teachers in the poorer States.

Go ahead, you are making a good statement.

Mr. COOKE. I would submit, Mr. Chairman, that even the golden State of California has trouble retaining its teachers today and I suspect Kentucky and other States have the same problem, too. We basically believe that the formula could be revised and it could be revised to reflect the magnitude of the problem in given States.

You could also use a formula which has been recommended by some of the people up here today that recognizes disadvantage or by recognizing unemployment. Any of those formulas would provide a more equitable distribution than this formula does.

With that, Mr. Chairman, I will end my testimony. Thank you very much.

[Prepared statement of Charles Cooke follows:]

PREPARED STATEMENT OF CHARLES M. COOKE, FEDERAL PROGRAM COORDINATOR, CALIFORNIA STATE DEPARTMENT OF EDUCATION

Mr. Chairman, members of the Subcommittee, thank you for the opportunity to appear before you to discuss this important bill, H.R. 30, the Emergency Mathematics and Science Education Act. My name is Charles M. Cooke and I am the Federal Program Coordinator for the California State Department of Education.

There is no doubt of the necessity to upgrade our nation in the disciplines of science, mathematics, and computers so as to meet the challenges of the future and increase the nation's productivity. We are now in the throes of a classic supply and demand problem. That problem is simply not enough science, mathematics, and computer teachers. Lack of adequate numbers of teachers thus forces many schools to use untrained teachers.

Untrained teachers, beside the likely poor instruction, help to exacerbate the problem of not enough science and mathematics majors. Which, in turn, leads to fewer science and mathematics teachers—thus, we have a wonderful catch-22 going on.

This bill and others are trying to break up that circular problem and address the major issue—the supply of qualified science, mathematics, and computer teachers.

In California, the supply problem may be described as follows:

It is estimated currently that the secondary public school system has approximately 20,000 science and mathematics teachers;

The current retirement rate of teachers from the public school system is about 5 percent per year; thus, it is estimated that nearly 1,000 science and mathematics teachers leave the public schools annually;

The large number of teachers who joined the system 25 years ago because of the postwar baby-boom will be retiring this decade, which will up the rate of retirement from 5 percent;

Additionally, the high demand for science and mathematics professionals in business, industry, and the military creates further erosion of the teacher supply in these areas;

Thus, the annual loss of science and mathematics teachers in the public secondary schools in California alone is more likely to be 1,500, and increasing as we approach 1990;

In the same time frame, declining enrollment in secondary schools will reverse in 1989; and

Thus, by the end of this decade we are likely to have more secondary students at a time when the shortage of science and mathematics teachers is likely to be at its greatest.[1]

All of the above indicates that the problem this bill addresses is a significant one and that it is a problem which cannot be solved by State and local efforts without Federal assistance.

The teacher supply problem has three major components:

Re-training and upgrading of current teachers; recruitment of new science, mathematics, and computer teachers; and retention of current science, mathematics, and computer teachers.

Analysis of H.R. 30 indicates, while it addresses in some degree the problems of re-training and upgrading the current teachers supply, and, to a lesser extent, the recruitment of new teachers, it does not address the problem of retention of current teachers.

Further, the funds authorized by H.R. 30 do not appear sufficient to support a large-scale attack on any of the three problem areas. As pointed out above, in California alone, the teacher attrition in these critical areas is likely to be 1,500 teachers annually for the near future and higher than that during the last years of this decade.

It is our belief that the bill could have greater impact if the Federal funds authorized in this bill could leverage other Federal, State, or local funds to assist in developing and maintaining our teacher supply in these areas. We think that the Committee should consider requiring matching funds from other sources in both Part A and Part B of the bill.

In Part A, a matching requirement of 50 percent would not be out of line and would double the impact of funds devoted to this problem. Federal funding, such as Chapter 2/ECIA, Vocational Education, Chapter 1/ECIA, and Special Education could be allowed to be counted as matching funds. Additionally, State and local funds dedicated to these purposes would serve as matching funds. Finally, funds received from local business and industry would count as matching funds.

---

[1] I am indebted for this analysis to Dr. James Guthrie of the University of California, Berkeley.

In the last category (funds received from local business and industry) a performance bonus might be desirable. If a district was able to obtain a significant percentage (perhaps as much as half of its matching funds) from local business and industry, such district would receive a performance bonus of perhaps 10 percent of its total grant (counting both matching and grant funds).

A further area which might enhance the effectiveness of this bill would be to ensure that the funds provided by this bill only support the highest quality inservice teacher training. In particular, inservice teacher training which is not tied to curriculum and instructional standards which have been set by the State or the local educational governing body is less likely to bring about the improvements in teacher knowledge and effectiveness that one desired.

The so-called information society, which many say our society has now evolved into, provides enormous amounts of information which is difficult to sort out and to make use of. One of the many functions of state education agencies is to carry out that sorting function and provide useful information and research to the local districts.

To ensure that the highest quality teacher inservice training occurs, we believe that such training must be explicitly tied to standards accepted by the State (although perhaps selected by the local governing board) and would recommend Section 604(a)(1)(A) be amended to reflect that requirement.

Furthermore in many States (California is one) there are existing regional inservice teacher training and upgrading institutions mandated by State law and governed by State standards. It would make sense to ensure that the school districts' expenditures for inservice training go to such regional centers and/or institutions of higher education that are providing quality inservice training in science, mathematics, and computers.

Section 604(a)(1)(A) could be amended to provide that school districts should expend the funds for inservice training at the regional inservice teacher training and upgrading centers and/or institutions of higher education. If such institutions do not exist, funds provided to school districts could be pooled as allowed under Section 604(b) to help create such regional institution and that section should be amended to allow such purpose.

With regard to the provisions governing the State use of funds received under this title, the bill does not appear to provide State educational agencies the authority to use the funds they receive to carry out (either on their own or through contracts) programs to upgrade or retrain teachers.

State educational agencies can and do have the capability to inaugurate Statewide innovative programs and such capability should be encouraged and supported. Section 605(a) should explicitly allow SEA's to use these funds to develop and conduct (or contract for) innovative projects to upgrade and train teachers, administrators, and others in these critical areas.

As in Part A, Part B does not authorize sufficient funds to operate a program of sufficient magnitude to meet the problem. Here, again, a matching requirement could be required for Sections 622, 623, and 625, perhaps as high as 50 percent, and a performance bonus for institutions of higher education who receive a significant portion of their matching funds from business and industry could be rewarding.

It might be possible to have a similar incentive with regard to Section 621, Congressional Scholars. Each member of the House or Senate could be allowed to nominate more than two candidates, if the business and industry located in their district donate half of the scholarship costs. For each half scholarship donated, another candidate could be nominated by the member.

[If the candidate is not selected, the funds donated could only be used to fund other candidates who were nominated by other members from the same State.]

The one major issue this bill does not address is the retention problem. We would suggest that a fellowship program be authorized in the bill. A specific amount of funds (perhaps 10 percent of the entire grant to State) could be designated to go to the State Board of Education.

These funds would provide fellowships for secondary school teachers of mathematics, science, and computers who had taught in secondary schools for a minimum of five years. The fellowships would provide for tuition, per diem, and district substitution costs for a period of up to ten weeks of upgrading in teaching skills and instructional techniques in science, mathematics, and computers.

Upon successful completion of the ten-week course, teachers would be given a certificate of graduation and a bonus of perhaps $2,000. The $2,000 bonus could be used only by the teacher to buy necessary equipment and/or instructional materials to upgrade instruction in his or her classroom.

Selection of the teacher fellows would be done by the State Board of Education acting upon nominations from regional educational institutions such as county offices of education and/or regional inservice teacher training institutions. Criteria for nominations would be established by the State Board of Education based on Statewide standards and competencies required.

We believe such provisions in the bill could significantly enhance the capacity of the education system to retain our current qualified science, mathematics, and computer teachers. They could also have a positive effect upon students making decisions to become teachers in these fields.

Mr. Chairman, that completes my discussion of the substantive issues of this bill; it is with regret that I turn to the major difficulty we have with the bill as currently proposed—the formula. I would hope that the Committee will be able to revise this formula to one that is significantly more equitable to those States with the largest student population, and thus the likely major suppliers of science, mathematics, and computer-trained personnel.

The table I have attached to this testimony highlights the problems of the current formula. Many of the large industrial States do not receive their equitable share. California, in particular, receives significantly less than its share of the nation's student population. New York, New Jersey, Connecticut, Massachusetts, Illinois, Pennsylvania, Colorado, Washington, and others are similarly shortchanged by the formula.

As usual, in formula, fights, equity is defined by the eyes of the beholder. However, I believe that it can be shown that the H.R. 30 formula is clearly inequitable. The attached table shows for selected States:

The percentage of school-age population and each State had in 1980;

The allocation of $250,000,000 on the basis of this percentage;

The allocation of each State if the H.R. 30 formula is used;

The percentage the H.R. 30 formula allocates to each State;

The gain or loss to each State comparing the H.R. 30 allocation to the allocation of percentage of school-aged population;

The percentage of public elementary and secondary school funding which each State receives from the Federal government; and

The per capita State and local expenditures for local schools (including capital outlays) for each State.

The table demonstrates that the H.R. 30 formula penalizes those States which have the higher costs of education (such as Alaska, New York, California, and others), which receive smaller shares of their educational funds from the Federal government, and which provide greater than average per capita State and local expenditures for their schools.

Further, the H.R. 30 formula clearly penalizes those States with most severe unemployment problems; those States which are most in need of major retraining and upgrading to re-tool their work force; and those States which have the larger numbers of high technology industries most in need of science, mathematics, and computer professionals.

Finally, in the case of our State, the H.R. 30 formula penalizes a State which is already making a significant effort on its own to address the science, mathematics, and computer problem. In a time of significant budget crises, California has nonetheless dedicated $19,000,000 to upgrading its teacher corps and to stimulating students to pursue science, mathematics, and computer careers.

Mr. Chairman, we believe this formula must be revised. The most equitable solution would be a formula which recognizes the proportion each State's school population represents of the nation's school population. Other variables which could be considered are the numbers of unemployed in a State and/or the costs of education in each State. However, to avoid a complicated formula, the easiest solution would be to eliminate the factor of personal income per child currently in the formula as it is a misleading comparison is assessing the cost of education.

In summary, we would recommend H.R. 30 be amended to:

Require matching funds for both Part A and Part B;

Provide a "performance bonus" to districts and institutions who receive significant contributions from business and industry;

Enhance the role of the State education agency in requiring high standards of training;

Provide for a fellowship program to enhance retention of current science, mathematics, and computer teachers; and

Provide an equitable formula recognizing States with the major shortages of science, mathematics, and computer professionals and the greatest need for retraining and upgrading.

Thank you, Mr. Chairman and members of the Subcommittee, for this opportunity to express our views and recommendations on this important bill.

Attachment.

ANALYSIS OF ALLOCATIONS UNDER H.R. 30[1]

State	Percent of school age population (5–17) 1980	Allocation based on percent of school aged population	Allocation if NDEA formula is used	Percent of total allocation if NDEA is used	Gain or loss	Gain or loss (percent)	Percent of revenues from Federal Government 1981–82	Per capita State and local expenditures for local school (including capital outlay 1979–80)
California	9.87	$24,700,000	$18,700,000	7.48	−$6,000,000	−24.3	6.77	421.14
New York	7.49	18,700,000	16,000,000	6.40	−2,700,000	−14.4	3.75	498.31
Illinois	5.06	12,700,000	11,000,000	4.40	−1,700,000	−13.4	8.63	405.52
Pennsylvania	5.01	12,500,000	11,700,000	4.68	−800,000	−6.4	7.63	401.24
Michigan	4.36	10,900,000	10,700,000	4.28	−200,000	−1.8	8.07	475.74
New Jersey	3.22	8,000,000	6,500,000	2.60	−1,500,000	−18.8	3.22	462.19
Alabama	1.82	4,600,000	5,500,000	2.20	+900,000	+19.6	14.80	302.08
Kentucky	1.69	4,200,000	5,000,000	2.00	+800,000	+19.0	11.85	314.06
South Carolina	1.48	3,700,000	4,600,000	1.84	+900,000	+21.4	13.60	340.20
Mississippi	1.26	3,200,000	4,000,000	1.60	+800,000	+25.0	23.00	308.16
Arkansas	1.05	2,600,000	3,200,000	1.28	+600,000	+23.1	13.04	327.50
New Mexico	.64	1,600,000	1,900,000	.76	+300,000	+18.8	12.01	485.92
National average							8.06	410.28

[1] Assumes $250,000,000 are allocated.

Chairman **Perkins**. Let me put a few questions to you, now.

We cannot enact legislation of this type without some controversy. There is no way to do it. We would like to get your suggestions and I would like to ask all the panel to respond to it.

We can begin with the gentleman from California. I would like to ask you, do you believe that the States should determine which school districts receive funds within the State or should the Federal law set out a formula going on to the school district level within the State?

Now, the reason why this is so important, I know you know we do not have the funds that we should have. If we had adequate funds, naturally we would channel it into every local school district in the country, and that may be what we should do anyway.

What is your answer to that question?

Mr. **Cooke**. Well, Mr. Chairman, in some ways, I am very attracted by the notion that you let the States determine how they would allocate money out to the districts. I understand that school districts are not exactly in favor of that process.

I do not have any real problems with the formula allocation. I think, however, you may want to think about doing some kind of minimum requirement, a minimum amount, similar to what was in old title I, whereby school districts that do not receive *x* number of dollars because they are small, will not participate in the program unless they get together with other similar small school districts in their area and by putting their formula amounts together, reach that minimum amount and therefore participate in a sort of consortium across several districts.

I think that is a useful notion. I do believe there is a finite amount of money that is needed in order to be able to provide any kind of a meaningful in-service training program. For instance, the kind of recommendation I was making for a fellowship in this bill, my guess is to do that correctly would cost you about $7,000 a teacher.

Now, if you run a formula on the basis of the $250 million in this bill, there is not going to be a lot of districts that have $7,000 to spend, so I feel like you need to put a minimum amount if you do it by formula, and I think you can have an equitable formula which flows to the district on the basis of need, and that can either be a straight school-age population or it could take into consideration disadvantaged students, rates of unemployment in the area, or whatever.

I think the formula is all right. As I say, as a State official, one always likes to have the flexibility to do whatever they want to do, but I understand there are a lot of people that would not like that.

Chairman **Perkins**. Mr. Casteen, you go ahead and answer the question.

Mr. **Casteen**. Mr. Chairman, I am in kind of a strange position with this because I work closely with local school officials, and I feel that their interests are important ones. But I think I would like to argue for the largest possible State role in determining how the funds are to be committed and for several reasons.

One is the matter of perspective. It seems clear to me at this point that the pace of change in recent times, and particularly the rising need for persons trained in newer kinds of technology that are based on mathematics and science, has made it very difficult at any level of education to gage what the needs are from day to day.

The fact of the matter is, I think in recent years, the dialog about changing needs and especially about the needs for more complex academic skills in our average graduates, that dialog has occurred primarily at the level that involves Governors and leaders of industry and business and States.

I should point out that in the course of the work of the ECS task force, we have come to realize that two dialogs are in progress. I have to oversimplify to represent the two dialogs, but one dialog takes place at the level of Governors and the business leaders with whom they deal. And in that dialog, the interests asserted are basically those addressed in the bill; that is to say, the need for average competence at a much higher level with regard to mathematics and science.

There is another dialog. That dialog typically takes place at the level of the local school or the local school division in which employers whose primary interest may be in workers who are best able to work on an assembly line or to do other kinds of work that do not require these higher order of complex skills, will be the interest most represented.

I think the point to be made is that if it is the interest of the Congress to try to see to it that our people are in general more competent in the next generation to deal with the different kind of economy than we are at the present time, there is a good argument for dealing with the level of government that has the perspective necessary to assign goals to set quantifiable measures and to try to see to it that we deliver dollars in places where we can meet that specific end.

Second, I need to make another observation, and that is that several speakers today have talked about the need for collaboration between higher education and public education.

The fact is that in most States, that kind of collaboration is possible only at the highest level of the executive structure in the State. It seems very clear that collaboration between the academic departments in our major universities and the schools of education comes about primarily as a result of pressure from the State political establishment.

But it should be clear, also, that the major needs that we need to address require a close kind of collaboration between our secondary schools and our middle schools and our colleges and universities, and coordinating that kind of collaboration is very difficult if the funds are vested primarily at the local level.

The State has a kind of interest in seeing to it that it gets the maximum return on all of its educational activity. Consequently, I think I have to argue that the State must be a party of some kind if it is, indeed, the purpose of the Congress in the end to enhance our capacity in mathematics and science.

Otherwise, there are structural features that make it very hard to achieve the purposes that the committee is addressing.

Chairman **Perkins**. Dr. Yager.

Dr. **Yager**. I think as indicated in our previous testimony, I would have to respond to this question saying that we see it very important to target what the specific goals would be in the various categories in the existing bill.

I think that we stand very much in favor of target, in favor of specific proposals and in favor, then, of a judgment in terms of funding upon merit, a peer review kind of thing, and it almost makes it immaterial, I think, from our standpoint as to whether the funds are administered through the State or certainly it seems difficult at the local level, unless we are just saying funding will result in improvement and it will make a difference without specifically spelling out the kind of improvements that we are after.

Chairman **Perkins**. Ms. Page.

Ms. **Page**. Chairman, I think you are asking this panel a question that goes like the little boy who went to the doctor and the nurse took him into the room and told him to strip to the waist. When the nurse came back in, he was standing there naked, and she said, "I only said strip to the waist," and he said, "You did not tell me which end to start at."

I think that all of us have that problem. You are asking us which end to start at. The important thing is that the doctor is going to be there to take care of that need and we hope this bill is going to take care of all our needs.

I will have to refer back to my paper, also, what I said. NSBA did a study, including areas of school systems that had only 200 to 300 students, those school districts indicated, and demonstrated to us, that even a small amount as $1,000, would definitely benefit them.

They have the capacity, they have the capacity to pool their resources, to use their university systems in their States, and that they could use that kind of funds. Again, as referred earlier by Mr. Goodling, the three women with the different opinions, we do believe the program is better designed at the local level to fit that local school district, with it being reviewed by either a State panel, a university panel, possibly a Federal-level panel.

Chairman **Perkins**. Go ahead.

Ms. **Knox**. I am happy to say that the organizations I represent are not going to jump into this State-versus-local debate. And our concern is that wherever the control over the money is vested, that there be an emphasis on meeting the needs and eliminating the barriers that women and minority males have.

Ms. **Goldsmith**. Mr. Chairman, the State Boards of Education clearly would believe that the States should be involved in the development and the distribution of any funds that come into the States, because State boards of education do, in fact, have the advantage of the long view of what is happening, what the needs are, where a local school district does have to deal with more immediate problems.

We do know that there is a great deal more cooperation today between higher education, elementary and secondary education, than there was even as short a time ago as 5 years, there are several State examples across the country that we would be happy to share in terms of cooperative efforts that we know did not exist in the past.

We would say if there are to be Federal moneys, that clearly if they are going to be directive, there ought to be set criteria, they ought to include some accountability. Any Federal fund should be a supplement and should not be allowed to supplant money that is already being spent in the States.

With those brief remarks, we look for the State involvement and through the State boards of education.

Chairman PERKINS. Greater cities, go ahead.

Ms. MCKENZIE. Mr. Chairman, the Great City School Council schools believes that the money should be distributed under a formula, perhaps similar to title I. Often when the money is distributed on loose criteria, urban and poor school districts suffer.

Chairman PERKINS. Go ahead.

Ms. RICE. Mr. Chairman, this is an argument I would prefer to stay out of and I am representing only my own past interest in education. I think we have a very uneven problem. We have heard a lot of statistics about the decline in the number of math and science teachers in the aggregate.

We need some more statistics on what the nature of the problem is in certain districts around the country. I tend—and we also have a very uneven problem and we have relatively modest funds to spend on it. I tend, just from my own past, to be highly in favor of targeting money to directing it at the problem areas, and there were several criteria that one could use to target.

Indeed, Mrs. McKenzie has cited the severe problems of the inner cities. Targeting by disadvantage is one way, targeting, as has been suggested earlier, by levels of what the employment needs are in the community, also, I think in this instance, since you are trying to address the need to improve the number and the quality of teaching, it could well be targeted by what that need really is, how many teachers does that community, have they lost, how many do they need, and what retraining needs do they require.

Chairman PERKINS. I want to ask one more question, I do not want to take up too much time here because we have so many Members who will have numerous pertinent questions. I recall back to the one time when I was a classroom teacher. I am wondering how we are going to get around problems of jealousy if we increase the salaries of math and science teachers above the salaries of the regular school teachers?

Some people would argue that is discrimination, but at the same time, they think their subject matter in the arts or in the humanities, history or anything else, is just as important as your math. But be that as it may, we all know from a realistic standpoint that industry is pulling these better science teachers and math teachers out of the classroom.

Now how are we going to hold them, can we hold them through seminars or something? Pay them stipends in the summertime? I want you people to comment on this question, I will go back to the gentleman from California again and come around the table.

Mr. COOKE. Mr. Chairman, we attempt to address this issue somewhat in my testimony. One of the reasons why that fellowship notion that I discussed, I think it does provide some incentive to the teachers to stay in the game. It gives them some rewards, and using a voucher of $2,000, and I am not fixed to that amount of money, but $2,000 for the teacher to take back with him or her to the classroom to improve their classroom, I think gets around one of the issues that you have with differential pay. It is not differential pay, but it is a reward, and I think that could be done without the opposition you get when you get into differential pay issues.

I think the notion of summer institutes is helpful, but I think it is not enough. I think the other incentives that are built into this bill are good ones, also, but again, I do not see it as enough. That is why I was suggesting the fellowship notion.

Chairman PERKINS. Go ahead, Mr. Casteen.

Mr. CASTEEN. Mr. Chairman, like the problem of linking State and local interests, I have a feeling this particular problem may be more apparent than real for this reason: In other sectors of education, differentiated pay and merit pay are fairly common instruments. I have served for a number of years as a trustee of independent college preparatory schools in which both types of pay are commonly used to retain teachers for whom there is competition or for whose services there is competition. With regard to math and science teachers, we have for a long time addressed the need in that way.

Second, in higher education, it is important to observe that both merit and the relative value of one's discipline have for a long time turned up as salary factors in calculating salaries in our most prestigious institutions.

And the alleged controversy within the faculty, the alleged creating of a secondary pecking order, those side effects simply have not developed in the institutions where I have taught. It is a fact of life that values in the labor market vary somewhat from one party to another.

Third, I make the observation that at least in the State in which I work primarily, the organized teacher groups have been far less adverse to this idea in recent months than they were previously, and the reason very simply is that the membership at the local level watched the departure of colleagues and realized the extent to which the labor market is indeed making it difficult for schools to maintain the kinds of services and functions that all teachers agree they should.

I think the fact is that the progress of the recession has created a kind of economic realism that may not have existed 2 or 5 years ago when the discussion began. The conditions supporting a solution have become much more prominent in recent months than they might have been previously.

Chairman PERKINS. Dr. Yager.

Dr. YAGER. I have some very mixed reaction about the question. I think as a person, I could support the concept of differential pay, but I do not really want to get into that and if I am speaking for my association, it seems that it would be inappropriate.

Chairman PERKINS. I agree with you, I do not think that part of the question is worth 10 cents. I hate to say that, but that is my honest opinion.

Go ahead.

Dr. YAGER. OK. We would be against increasing the pay of science and math teachers over and above other teachers. However, we do feel that there are ways within existing policies that recognition could be given. We see, for example, that this would be a fine opportunity for partnerships with industry where programs were set up in a community that science and math teachers could perhaps work in research laboratories, gaining in a sense, extra pay, but at the same time, extra experience.

It would bring a more practical kind of science and mathematics to the classroom. We see that there could be various kinds of enrichment programs for students. Again, when we talk about test scores, when we talk about the lack of involvement, the lack of interest in science and mathematics, that the summer again would be an ideal kind of time for teachers to be involved with gifted students and perhaps students at the other end.

Again, it would make the profession more attractive. It would be a way of increasing the pay, but increase involvement.

We see a concept of science teaching particularly being experience based, and if there simply is not time in the regular school day to involve students and with their students in direct experiences in the community even during the academic year. In some communities, for example, I ran into this in Wyoming where they are experimenting with the concept of science coaches, much the same way that people in athletics get extra pay for extra work and extra involvement.

We see this as a very fine kind of response, instead of not just raising the pay because they are science and math, but for specific functions.

Ms. **Page**. Mr. Chairman, putting on my other hat as a local school board member, Florida has been doing an indepth study over the last 2 years and I serve on that panel on this very subject.

We have been taking testimony from all of the large industries in the State, and their recommendation and the recommendation of the Commission is based primarily upon more cooperation between business and industry with the educational system.

We have found that the interaction between the practitioner in the field, the profession, and the practitioner in the classroom is very important.

The word "merit" raises the hair on the back of my neck because I come from a State with a collective-bargaining law. The term "merit pay" gets very, very sticky when you start doing that.

I think there are many, many resources for using what you were referring to, I would call a master teacher. Is that what you were referring to?

This is what we are looking at in our State, where the teachers that are the best, the "master teacher," then, could receive a different salary level and, in turn, be the teacher that is responsible for the other teachers beneath them. That could easily fit into a collective-bargaining situation for those States that have to deal with that, but, you know, if you do not have to deal with it, you just stay out of it.

But it is putting on and speaking nationally, I would have to say I think our answer would be not a different pay scale, but definitely more cooperation and particularly beginning at the postsecondary—it is not just K through 12, but the postsecondary area, looking at those people entering those fields to teach.

Ms. **Knox**. The organizations I represent do not have a point of view on this issue, but I do have some personal comments. One is that the shortage of math and science teachers is an extreme expression of a problem, an overall problem in education, in that we do not pay teachers well, anywhere.

Since women have been the majority of elementary and secondary public school teachers, with a lot of new opportunities opening up in private industry to women, women who would have been teachers in an earlier time are seeking jobs in industry and that is an overall problem in the education system.

The other thing I want to say is that if studies in industry are any example, pay is not the primary factor in worker satisfaction; teachers are workers, and industry is beginning to realize that the way to hold and develop skilled people and solid employees is through involving them in improving companies and in the development of a work environment that is satisfying and works for them.

A lot of math and science teachers are teaching with textbooks that are out of date, they are teaching techniques that many of the young people in their classrooms cannot relate to, and in the process of revamping the curriculum, teaching techniques, and bringing the modern world into the classroom, I think we will be offering teachers satisfaction in their jobs that many of them are not now experiencing, and that is going to be at least as important as pay.

Ms. GOLDSMITH. Mr. Chairman, I would like to associate our association with what Ms. Knox has had to say. Certainly we would agree with what the comment she has made about teacher salaries.

We would certainly think that setting teacher salaries is not a Federal responsibility, and ought to be worked out through the contract negotiations that go on through local school systems and their local teachers associations and do think that merit pay, master teachers, is something that ought to be handled at the negotiations table.

We think within that, there are room for pilot projects and we know that there are programs going around the country, one that comes immediately to mind is the city of Houston, where they are doing some changes in the marketplace and doing some things like some bonus pays, and there are ways to look at the problem which we have not looked at in the past 25 years that we might want to look at again, but I do think it is something that State and locals can work out, maybe with some Federal encouragement, but certainly that is not one of the places that we think that the Federal Government ought to be involved.

Thank you.

Ms. MCKENZIE. Thank you. As a school superintendent, at this point in time, I do not believe that a salary differential is appropriate. I support Holly Knox's comments with respect to job satisfaction. I think, however, we can provide other incentives and some we have tried in the District.

For example, in preparation for preengineering programs at one of our high schools, four teachers went to the General Motors Institute for 6 weeks this summer in Flint, Mich. They were paid a salary and General Motors threw in things like a car for use on weekends, with money for gas, and these teachers were very excited and rewarded by that experience.

Others worked in the Potomac Electric & Power Co. here and other private-sector companies were involved in this preparation period, as well as our administrators participated in these kinds of experience, and it seemed to bring excitement and enthusiasm to the teaching the subsequent year.

I would also be in favor of extra-duty pay for cocurricula activities in science and mathematics that would enrich the curriculum and these activities would perhaps be carried out in an extended day or an extended week.

Thank you.

Ms. RICE. Mr. Chairman, I think it is a vexing concern, but maybe this bill does not have to address the issue. As has already been suggested, in business, we do reward performance, I mean, there are salary ranges for each type of responsibility, but there are incentive rewards for outstanding performance. It is not simply the outstanding performance of math and science teachers that we might want to address; it is the outstanding performance of being a teacher.

I think that there could well be these kinds of bonuses or performance incentives. On the other hand, I think that the marketplace is going to have to determine the level of salaries for any discipline, and I think that we are only going to begin to resolve some of these problems when school systems become competitive with industry for the same types of talent.

Chairman PERKINS. Mr. Goodling.

Mr. GOODLING. Thank you, Mr. Chairman, I would just like to make two general observations and then a couple specific ones. My general observation, first of all, would be that I hope that this committee would never get in the business of determining differential pay for certain teachers.

You can say all you want about the private schools and so on, but when you talk about private education, of which I was a part for a long time, let me tell you, first of all, that the social studies teacher and that English teacher envies that math and science teacher who may have 8 or 10 in their class, and not only that, but 8 or 10 people who want to be there, while they have 35 in their class, 30 of which do not really want to be there.

So I would not want us to get caught in that in any way, shape, or form. However, I agree with Dr. McKenzie and others who said there are so many other ways to do this and the involvement of industry with these math and science teachers is a must.

We have to make sure that in anything we do to encourage the private sector to get involved, we also have something there that says they may not steal that teacher for a certain amount of time because I have seen that happen too. I have had too many who went to work in the summer for a private firm and loved it so much and were paid so well that they forgot to come back, sometimes with not very much notice.

The second general observation I would like——

Chairman PERKINS. Let me say to my friend that I am a great fellow for local control. I have been all through the years, but I think it was well to get the reaction so that we put some language into the report about some of these problems. I know some of the unions may raise some questions, and we ought to have comprehensive hearings along that line. That is the reason I have gone into it.

Go ahead.

Mr. **Goodling**. Oh, well, I agree with you. I was not questioning your line of questioning. I may have been throwing a comment to the gentleman who did so well this time, and who did so well the last time he was here for truth in testing. In fact, we have a couple familiar faces here on that particular issue.

The other general observation I would like to make, is that unless we find some way to break down this business of where the money should go, who should have the control, who should have the power. Both from being in education and in 8 years, we hear this testimony over and over again that the State chief school administrator would like it to come his way; the State board says, no, we had better bring it to us, and some State school administrators would not like that. Then the local school boards say, hey, we do not trust the State; you had better not send anything there. Then the local administrators say, well, now, be sure to include us because our school boards might not do that, and on down the line. That just deters us from doing the kind of things we have to do in education.

As I said, I realize the situation is improving, but listening to the testimony yesterday and listening to the testimony today, it has a long way to go and I would hope that we would continue to try to remedy that particular situation.

One third, general observation I should make is that we have to be realistic. I realize that what we are talking about sounds like an awful little for an awful big program, but I also know that Senator Domenici, for instance, has introduced his bill. I do not know what the bill is, but I know his bill calls for $200 million on elementary and secondary and $21 million for postsecondary.

When we talk about compromise and conference and all that, we are going to have to be realistic. I do want to say that your testimony was very valuable because as I told the chairman originally when I became a part of introducing this bill, I looked at it as a shell and I realized there is a lot we must put inside that shell.

The testimony that you are giving is the kind of material that we need to put in that shell so that we come up with something that is truly worthwhile and no matter how little the financial amount may be, it is going to make a difference.

That is what we are here for. I will forego all the questions that I wrote on these pages as you were testifying because, so many times, the people sitting down further do not get a chance. So I will yield back any additional time that I might have.

Chairman **Perkins**. Thank you. Mr. Miller.

Mr. Boucher.

Mr. **Boucher**. Thank you, Mr. Chairman. I have just a couple of questions of Mr. Casteen, if he would be so kind as to answer.

In your discussion in your prepared testimony of Indiana Governor Orr's agenda for excellence, you mentioned retraining of teachers that are presently qualified in other disciplines to teach math and sciences.

Are you aware of any programs in the country today where teachers qualified in, say, English or history, are being retrained for these skills?

Mr. **Casteen**. Mr. Boucher, I doubt that I could put my hands on a specific program, but the committee may be interested in a pair of yellow sheets, three yellow sheets attached to the written testimony, surveying State initiatives.

You will find references to such training programs about specific States indicated. One thing that may interest you is that in meeting with my own mathematics teachers in Virginia, I have discovered that in some districts, we have marginal surpluses, not major surpluses, but marginal surpluses, of teachers who are qualified to teach mathematics and science at the middle school level.

Their local districts are often able to provide funds that will allow them to take additional courses and become certified to teach at the secondary level. We have identified teachers who are doing that successfully in the city of Richmond, Henrico County, which is the adjacent jurisdiction.

I think the point to be made about that is that retraining any adult is a complicated problem, and that as we face the fact that in general, teachers define themselves in part in terms of their discipline, that is, their vision of what they are professionally, has to do with the discipline. That is an approach that requires a very personal articulation. It depends on the teacher and the circumstance and the demand for the service and so on.

But I think it is fair to say that with proper leadership, and this is a local matter, with proper local leadership, there are instances of success in that very enterprise.

Mr. **Boucher**. On page 5 of your testimony, you point up the need for, and I will quote, "tangible goals and quantifiable purposes." By that, do you mean that Congress, through this legislation, should set some sort of timetable for teacher training, or if not, do you believe that those timetables would be better set by State governments?

Mr. **Casteen**. Mr. Boucher, let me come at that in a more general way. What I am trying to say is that if, indeed, it is the will of the Congress that we improve performance in our schools in mathematics and science, at some point, and I think this is a response in part to Mr. Goodling's very useful suggestions on the same observation, we have to set some hard goals and achieve them.

The process of brokering or leveraging virtually every effort to improve education, sooner or later dilutes the purpose. So essentially, I am saying that if the purpose is to improve mathematics and science, we need to identify ways in which we have done that successfully, and there are many such ways.

Again, the yellow sheets elaborate a few that had to be State initiative, and having done that, I think it is in the best interest of the Congress for the dollars to be directed to activities that demonstrably work and measured in terms of very hard standards as to what is the purpose of this particular expenditure and how do we verify that the effect was achieved.

The kind of grant that simply distributes dollars without the intention of measuring and labeling success and the opposite of success sometimes has the effect of perpetuating the worst of what we do and not encouraging the best.

Mr. **Boucher**. So you would suggest that we not have specified timetables in this legislation?

Mr. **Casteen**. I have had a lot of problems with goals and timetables both lately, Mr. Boucher.

Mr. **Boucher**. Just one final question. In previous testimony before the committee, it has been indicated that the shortage in math and science teachers is not uniform nationwide, and indeed, it may not even be uniform in a given State.

Can you give me some indication of how Virginia ranks in association with other States in terms of this shortage?

Mr. **Casteen**. We are somewhat better off than other States with regard to both mathematics and science. Like many southern States, our shortage in the sciences clusters in chemistry. It is not that we have a surplus in physics, we have an even greater shortage of students there at the secondary level. In biology, at least in Virginia, we are keeping pretty much even with the demand.

In mathematics, the shortage is most severe in the urban areas, and the reason obviously is that competing employers are most numerous in the urban areas.

In the areas where we have the best teacher salary schedules, and here I think I can underscore the validity of other comments made today, we have the best record in keeping science and mathematics teachers in the schools.

So in northern Virginia, for example, which is our most prosperous region in terms of school finance, appears to be somewhat ahead of the State in retaining top-end teachers in mathematics and science.

Mr. **Boucher**. Thank you, Dr. Casteen. Thank you, Mr. Chairman.

Chairman **Perkins**. Mr. Gunderson.

Mr. **Gunderson**. Panel, I want to apologize for not being here during all of your testimonies. You are a very distinguished panel, unfortunately we are organizing in another committee for the next 2 years and that has a great deal of importance for me. I can assure you that I will be going over your testimony this weekend.

The chairman brought up a couple of key points that I wanted to probe, but I would like to follow up on one that has not been discussed yet. That is, what comes first? It is sort of like the chicken and the egg, but we have got a limited amount of money, and under a wonderful Pollyanna world, we would like to have updated curriculum; we would like to have upgraded in-service; we would like to have better equipment; and we obviously would like to have more programs to train, retrain or maintain teachers.

But I think we need to determine where we begin. Do we begin with the personnel, is that the major problem? Is the curricula the major problem, is the equipment the major problem, or is it something other than one of those three?

I would be happy to hear from any or all of you on that issue.

Ms. **McKenzie**. If you do not mind, I will just start. Very quickly, I think that it is not an either/or. Some school districts are ahead when it comes to equipment, some are better off with respect to training of teachers. Others might have curriculum materials.

So I think that a needs assessment would determine what a school district or a State needs, and having the flexibility to deal in any of the three areas.

Ms. PAGE. I would have to agree. We have found that school systems, individual school systems around the United States, are taking long, hard looks at their own curriculum requirements for graduation in high school. They have increased their math and science and language requirements.

I think it really begins there. And then I think it goes into postsecondary. The requirements of people going into teaching have been very lax. The university system, the colleges of education are very hard to change. And they have recognized that there have to be some changes made there.

Then those people that go into the classroom, we come back to the question that was asked earlier. How do we keep them in the classroom once we get them there? But it is the same as Ms. McKenzie said, which comes first, the chicken or the egg?

But I believe we start with them in K through 12 with a good, solid background and then urge them to go on, because it is very easy not to take a math course and take something that is much simpler to get your GPA up so that you can graduate.

We have got to make our young people understand that it is important to take those courses and they are going to have to be mandated.

Dr. YAGER. I would say, Mr. Gunderson, that in my opinion, the first thing that we need is to decide and to define more carefully what the problem is. We say that there is a shortage of teachers; well, I think there is a way if we really want, literally, more teachers that are certified and qualified.

I think we might get into somewhat of a debate in defining what a qualified teacher is like. It seems to me that it is worthless to talk about, for example, equipment money unless we are talking about equipment for a certain kind of program. I think there is clear evidence that we have done an outstanding job during the 1960's in both science and mathematics with getting people ready for careers in science and mathematics.

As I mentioned as a part of my testimony, and there is even more in the written statement, it seems to many of us that the primary concern is a population which some have set as high as 90 percent, which is incapable of acting in today's scientific and technological society.

If that is a major goal, to improve the general literacy, understanding what science is, we probably need a vastly different kind of teacher, vastly different kinds of an instructional program, certainly different kinds of material.

So it seems to me that the first thing is to set the agenda. It is pretty easy to say that we have got a problem. It is also pretty easy to say, give us more money, the problem will go away.

We have a long history that problems do not go away simply by sending money out someplace to solve the problem.

Mr. GUNDERSON. Thank you, Mr. Chairman.

Chairman PERKINS. The lady there wants to say something.

Ms. KNOX. Yes, I do. My associate is here with me today. Dr. Pamela Surko is president-elect of the Association for Women in Science, and I want to say on her behalf, and on the Association's behalf, that we all feel that it is essential to have teachers who know science and who know math and are excited about those subjects.

Without that, we are not going to get far.

Chairman **Perkins**. Mr. Miller.

Mr. **Miller**. I have no questions at this time, Mr. Chairman.

Chairman **Perkins**. Mr. Bartlett.

Mr. **Bartlett**. Thank you, Mr. Chairman, and my compliments to the panel for providing a great deal of information to this committee in a well-organized way in a short period of time.

I would especially note to Ms. Rice of Control Data that I did appreciate your approach of the involvement of industry, and I would detect from your testimony you have some specific suggestions for ways that this bill could be structured to be more permissive in allowing school boards to structure their programs to involve local industry.

I would suggest to you that as you see this bill developing, if you have additional suggestions to make the bill more permissive to allow—not to require, but to allow school districts to involve industry.

I believe that that is the correct approach, and I hope to pursue it.

Ms. **Rice**. Thank you very much, I shall.

Mr. **Bartlett**. Mr. Casteen, your testimony provided really an outstanding listing, and by no means comprehensive, of all the ways that many school boards, both at the State and the local level, have begun to place math and science education as a national priority.

Whether Congress acts or not, I suspect that that national priority does exist and exists at the educational level right now even as we speak, and of course what this committee is determining is whether there is an additional role for the Federal Government in which we can be helpful in enticing education, and I guess my question would be—and I detect it from your testimony, then, but I would like for you to elaborate if you wish, and if you agree, as to whether you would urge this bill to be written in more of a block grant approach to permit school boards or the State board of education, whoever is making the decision, to make their decisions about how to structure their own program and to use this bill as a vehicle, but by no means a mandate in specific areas?

Mr. **Casteen**. Mr. Bartlett, I have to answer that in two pieces to begin with.

It seems clear to me that the Federal interest in this issue differs substantially from the several interests of the States. There are national priorities and issues with which mathematics and science are intertwined. It may not necessarily be those of the given State.

When we start to differentiate between the interests of the States and the local school boards, let me say first of all that I think experience of recent years as school finance has become taut, as we have had to trade off one good for another because we could not afford everything, rather than showing us a history of increasing factionalism within education, has shown us that we do, to a large extent, develop ways to collaborate that in past times we would not have predicted.

I think in more prosperous times, we tended to fight more over the pot than we have in recent times. The collaborations between higher education and public education in many States result in part from the realization that there is not enough money at this point to fund everything that everybody wants.

I have suggested that the State interests ought in some way to be represented in the bill because of what I tried to describe earlier as two perspectives that I am perceiving with regard to the purposes of education in math and science.

I think that the committee and the Congress, if it is your will to encourage math and science education, will find a closer kind of collaboration and a more immediate sort of receptivity at the State level and perhaps will turn up in all localities.

I will not deny that in many localities, the conscienceness that I think this panel represents is common. On the other hand, I think that it is necessary by building in measures of performance and specific ways to see to it that high-need populations receive resources to see to it that the program does not become a mechanism by which State government might increas its governance authority over local activities. That is not my purpose.

So whether the mechanism is a block grant or something else, I guess what I am suggesting is that the interests of the Congress are likely to be best served by some kind of carefully articulated collaboration between State planners who in general will perceive the problem as the Congress probably does and local school districts that face a vast variety of different local circumstances, different local priorities.

It must clearly be able to respond to those, but in the context of a large assertion of national purpose, a separate assertion of State purpose with State priorities that I suspect will parallel yours, and finally, local conditions that will drive dollars to specific local programs.

Mr. **Bartlett**. Thank you.

Ms. Page, in your tm, you had some similar, but from a different perspective, direction in terms of talking about whether this bill ought to specifically mandate specific programs or be permissive to school districts.

You suggested, for example, that advanced funding not be required so we can get on with the emergency of it. You heard Ms. Rice talk about additional ways to involve industry. I wonder if you see from the school board perspective additional ways that this bill could be structured to permit school districts to set their priorities.

My colleague had asked earlier about which is best or which comes first, which of the three, four or five different aspects of this should we start with. I think you all answered, well, the answer is different for different places.

I wonder if you would have us give that authority to the school boards?

Ms. **Page**. Naturally, I would. I do not think there is any school program that can be designed for any single student or any school district from the Federal level. There are no school districts that are identical.

I think that the program is best designed at the local level, and if there needs to be a meeting of the minds of local school boards and

State school boards, and, by the way, we do meet and we do talk and we are friends. It would be possibly a review-type of thing, but that the responsibility should lie with the local school district and with the needs represented there.

The needs are varying everywhere, but it has become, and I would have to agree 100 percent, I think, with what Dr. Casteen has said, it is a major concern right now of all of us everywhere.

Mr. BARTLETT. Thank you.

Thank you, Mr. Chairman, thanks to the panel.

Chairman PERKINS. Mr. Boucher, any further questions?

Mr. BOUCHER. No further questions, Mr. Chairman. Thank you.

Chairman PERKINS. Mr. Goodling.

Mr. GOODLING. Just three other comments and one question, Dr. McKenzie.

First of all, when I was listing to the groups that we have got together, I left out a very important one and that one is the parents advisory groups. Yesterday, when one of my colleagues was testifying, he was talking about the merits of the Japanese system, and I told him I have a lot of questions about how it is organized, et cetera. I was also wondering how many grievance committees they have and how many parent advisory groups they have that have made their system so excellent.

Holly, I merely wanted to say that you gave me some ammunition for when I talk to my daughter tonight, because after all of her years in school, including 2 years in college, she asks me my opinions, as my wife does, and neither of them ever take them. So I was glad to hear that you said we have a real influence on our daughter's course selection.

Seriously, we talked a lot about secondary and postsecondary today, too, and I made the statement yesterday, and the whole time we were trying to put this bill together, that I do not see any changes coming about unless we really put a lot of emphasis on the elementary level.

I do not see how you are going to postpone a youngster's enthusiasm for math and science until sometime in junior and senior high school. We have those teachers out there who have to teach all subjects, and probably have had one course in college on science and maybe one on math, and it was probably a methods course or something of that nature; and there they are trying to encourage little youngsters to get all enthused about math and science.

So I would hope that as we put this bill together, we really put some emphasis on the elementary level.

Dr. McKenzie, one question. At the bottom of 6, the bottom of page 5 and the top of page 6, you made a statement and Rich looked to find whether it was in your testimony because I thought maybe I had misunderstood.

It says:

> The situation that we have outlined has substantial implications for city schools that contain such large proportions of minority youth. Our fear is that the new legislation will only widen the gap between poor and nonpoor schools and consequently between poor and nonpoor citizens.

I did not quite understand that. Certainly this would not be the case through the chairman's formula.

Ms. McKenzie. Right. I think my comment there pertained to the fact that if the legislation is not targeted, then that possibility does exist.

Mr. Goodling. OK, I am a strong pusher for targeting. We will work that out.

Ms. McKenzie. Thank you.

Mr. Goodling. Thank you. I have no other comments. Again, thank you very much for your excellent testimony.

Chairman **Perkins.** Let me thank all of you. This has been a very constructive hearing, and you have all made a great contribution.

Undoubtedly, we are going to get a bill. It is a question of how much money we are going to put in the bill. I understand that the Senate now has raised their sights up to about $221 million.

So we will get a bill and we hope it will work out fine and strengthen science and mathematics throughout the whole country.

Thank all of you.

[Whereupon, at 12:28 p.m., the committee was adjourned, to reconvene subject to the call of the Chair.]

HEARINGS ON MATHEMATICS AND SCIENCE EDUCATION

Part 2

FRIDAY, JANUARY 28, 1983

House of Representatives,
Committee on Education and Labor,
Washington, D.C.

The committee met, pursuant to call, at 9:35 a.m., in room 2175, Rayburn House Office Building, Hon. Carl D. Perkins, presiding.

Members present: Representatives Perkins, Simon, Miller, Kildee, Williams, Goodling, Petri, Craig, Gunderson, Bartlett, and Packard.

Staff present: John F. Jennings, majority counsel; William A. Blakey, counsel; Lisa Phillips, majority staff assistant; Betsy Brand, minority legislative assistant; and Richard DiEugenio, minority senior legislative associate.

Chairman **Perkins**. This morning the Committee on Education and Labor is continuing hearings on H.R. 30, the Emergency Mathematics and Science Education Act.

This legislation authorizes $300 million for fiscal year 1984 and such sums as may be necessary for fiscal year 1985 for programs to upgrade mathematics and science education and to address teacher shortages in these subjects.

The bill would provide funds to local school districts for elementary and secondary programs of inservice teacher training and modernization of mathematics and science instruction. At the postsecondary level, H.R. 30 authorizes congressional scholarships to encourage students to become mathematics and science teachers, and other activities.

I feel strongly that improving mathematics and science education programs ought to be a priority of the 98th Congress. I am also glad to hear the President say that it will be a priority of the administration's this year.

Mr. Simon.

Mr. **Simon** [presiding]. Thank you, Mr. Chairman.

Today, the third day of hearings held by the Committee on Education and Labor, will concentrate on the second section of H.R. 30 which deals with postsecondary issues. The postsecondary sections address various needs of the higher education community in attracting and preparing education majors to teach math and science in elementary and secondary schools, and focuses on the capacities of colleges and universities to upgrade teacher skills through summer institutes for those currently in the profession of teaching.

In addition, the legislation provides for funds to upgrade instructional equipment at postsecondary institutions for students of education and allows for competitive grants to 2- and 4-year colleges and universities to provide for program development to address curriculums which have a direct bearing on training or retraining for today's high technology employment market.

H.R. 30 also provides moneys for educational research to support the development of knowledge and information resources for the improvement of teaching and learning in mathematics and the sciences as well as research aimed at improving instructional materials and basic research on the scope of the problem and student achievement.

The critical need for foreign language capabilities among the business, technical and international trade communities points to foreign language study as equally important to the economic well-being of our Nation, as is a technologically literate work force. I plan to offer at least one amendment to H.R. 30 to add foreign language studies as a discipline which can receive funds under this emergency act.

I might add, I have some concerns as we move ahead here, that Congress and the Nation should not be saying that math and science, important as they are, are more important than having good second grade teachers, or good teachers of English literature, or good teachers in any other field. I have some concerns as we are moving ahead on this. I am not opposed to recognizing the very real problems in math and science, but we have problems in other areas, also. I hope we don't lose focus on those things.

I'm not going to read the rest of this statement but will simply enter it into the record.

[The opening statement of Congressman Paul Simon follows:]

Opening Statement of Hon. Paul Simon, a Representative in Congress From the State of Illinois, Jan. 28, 1983

Today, the third day of hearings held jointly by the Subcommittee on Elementary, Secondary and Vocational Education and the Subcommittee on Postsecondary Education will concentrate on the second section of H.R. 30 whichs deals with postsecondary issues. The postsecondary sections address various needs of the higher education community in attracting and preparing education majors to teach math and science in elementary and secondary schools, and focuses on the capacities of colleges and universities to upgrade teacher skills through summer institutes for those currently in the profession of teaching. In addition, the legislation provides for funds to upgrade instructional equipment at post-secondary institutions for students of education and allows for competitive grants to two and four year colleges and universities to provide for program development to address curricula which have a direct bearing on training or retraining for today's high technology employment market. H.R. 30 also provides monies for educational research to provide for the development of knowledge and information resources for the improvement of teaching and learning in mathematics and the sciences as well as research aimed at improving instructional materials and basic research on the scope of the problem and student achievement.

The critical need for foreign language capabilities among the business, technical and international trade communities points to foreign language study as equally important to the economic well-being of our Nation and a technologically literate workforce. I plan to offer an amendment to H.R. 30 to add foreign language study as a discipline which can receive funds under this emergency act.

Along this line, there are critical areas of study which have appeared at different times in our Nation, and which have been addressed through specific legislation such as the National Defense Education Act. We may, in the future, find ourselves with a shortage of quality English, history or social science teachers. While it is clear that the present critical shortages are mainly in the areas of math and science, I believe that targeting Federal assistance in these areas should not lock out other disciplines where shortages may exist. I also believe that it is as important to have quality instruction in the humanities, social sciences and arts as it is in technological fields. The funding of summer institutes in H.R. 30 may well apply to teachers in concentrations other than math and science, if not within the focus of this particular bill, but in any extensions, revisions or reauthorizations in the future. In an article from the January 24, 1983, publication of the American Association of State Colleges and Universities, a recent National Science Foundation study of industrial firms points out that the demand for college graduates with science and engineering degrees fell in 1982. While math and science training is an acute problem, fluctuations in demand, and what may be the beginning of decreased demand, point to a requirement that we should not look to math and science training alone as pivotal courses for elementary and secondary students. The structure of summer institutes for teachers aimed at math and science in H.R. 30, should also allow for study by other teachers in order to create a well qualified corps of school teachers in all fields so that responses to changing needs will not be on an emergency basis in future years.

Rather than concentrate on the math and science problem highlighted by witnesses in previous days and in hearings in the 97th Congress, I would encourage our witnesses who are leaders in the fields of education, science, mathematics and engineering—to make specific recommendations about ways to improve or modify H.R. 30. I want to underscore, however, the importance of recognizing the Committee's budgetary limitations in enacting this new law.

Mr. SIMON. I will yield to my colleague from Pennsylvania for any remarks he might have.

Mr. GOODLING. I only want to say that I have some of those same kinds of concerns. However, in a math and science approach, I think we really could help elementary teachers if we gave them an opportunity to understand a little more about math and science and gave them some courses that prepared them to teach math and science, because what happens now is that the youngsters reach the junior high or senior high school level and then someone is going to try to encourage them to be interested in math and science. They probably had more interest when they came to kindergarten than they have when they get to junior high school. So this program, if we work it out right, at least might give those elementary teachers that opportunity.

As I have said to Congressman Simon, I also have some concerns about which people participate in the postsecondary program, because you can't really tell whether someone has a snowball's chance in Hades of becoming a teacher until after you see them in student teaching. They may be the best math and science students in the world, but the lousiest teachers. I think we have to concentrate a lot on retraining those who are in the field of teaching and encouraging them to come with us rather than go into industry.

So I think I will agree with Congressman Simon. We have a lot of work to do. We have a shell and we want to fill in that shell and have something that will really do the job. We have to be very careful. We have limited funds. We can't spread those limited funds too far because then we will really do nothing. As the Chairman said yesterday, the Senate has introduced a bill that talks about $221 million. If we're talking about $300-and-some million and they're talking about $200-and-some million, you know we're not going to $500-and-some million, apparently, so we have a problem there and have to be careful that we don't spread ourselves too thin, as we did eventually to the whole NDEA thing. You know, we kept adding and adding and adding without correcting the problem that existed.

Unfortunately, I won't be able to hear a lot of your testimony, but I will read it and my staff will give me the input in the exchange, because before this hearing was set up, I was set up back in my district to meet some very irate farmers at noon today, and it takes me 2 hours to drive there. Now, we're going to ask Congressman Brown to solve all those farm problems and I won't have to go back and meet with them. But in the meantime I have to face them.

Mr. SIMON. Let me yield to the chairman of the full committee.

Chairman PERKINS. Let's let these gentlemen testify.

Mr. SIMON. All right, we will accede to the wishes of the chairman and hear from our distinguished colleague from Missouri. It is a pleasure to have you here, Congressman Ike Skelton.

STATEMENT OF HON. IKE SKELTON, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF MISSOURI

Mr. SKELTON. Thank you, Mr. Chairman. It is certainly a pleasure to be with you this morning.

Mr. Chairman and members of the committee, I appreciate this opportunity to speak with you regarding the future of science, engineering, and technology education in the United States, and the impact deficiencies in these areas will have on our economy and on our national security.

As a member of the House Armed Services Committee, I have a particular concern over the effect shortages of technically trained manpower will have on the various military services, and also the impact of shortages on Department of Defense civilian personnel, the defense industry, and the defense industrial base.

Because of my concern in this area, I introduced legislation last year to establish a National Commission on Science, Engineering, and Technology Education. The bill which we are considering today, H.R. 30, also acknowledges the need for a national coordination of efforts to improve science and engineering education in the United States and to maintain the technological edge which has kept our country a step ahead of the international community for generations.

Today, Mr. Chairman, we are on the brink of a "technological revolution" which will demand a broad expansion of requirements for engineers and other technical manpower. Statistics reveal that 50 new electronics companies have been forming each month in our country. We are approaching a new and exciting frontier, but as the President said in the state of the Union address on Tuesday, we must be prepared to make these changes work for us and not against us.

Early last year I released a study which I had requested from the Library of Congress on the status of science and engineering education in the United States. I would like to submit a copy of this report for the record. Shockingly, the report reveals major problems ahead in meeting this country's needs for scientists and engineers in several critical areas. A shortage of trained technical personnel would have serious implications for our defense posture, which relies on sophisticated ships, planes, and tanks. It also would have a negative impact on our economy which depends on the skills of scientists and engineers for advances in agriculture and industry. Mr. Chairman, if shortages of scientists and engineers are not recognized now, and not acted on now, we are going to find ourselves in a technology gap that will be far more serious than the "Sputnik Gap" of the fifties.

While there has been an increase in the number of undergraduates enrolled in engineering and computer science in recent years, the supply of graduates will still fall short of anticipated demand in several vital areas. About 1.4 million scientists and engineers are going to be needed to fill anticipated growth and replacement demands by 1990. The Air Force, however, predicts a 114,000 total shortfall of engineers between now and then. Shortages of trained personnel are expected in industrial engineering, aeronautical engineering, chemical, electronic and nuclear fields, computer science and statistics.

This situation has particularly serious implications for defense. U.S. ships, planes, and tanks have become increasingly more complex and reliant on high technology. Both the armed services and the Department of Defense, however, are experiencing problems in recruiting and retaining technically trained personnel. Almost 10 percent—$22.7 billion—of the fiscal year 1983 Department of Defense budget is for research, development, testing, and evaluation. The Department of Defense employs 61 percent—53,712—of all engineers employed by the Federal Government. None the less, the Air Force reported that 57 percent of its present civilian vacancies are for engineers, and in 1980 the Navy reported that it needed to hire 1,950 engineers at the entry level, but was unable to fill only 53 percent of its needs.

All three services report shortages of qualified personnel in the scientific and engineering fields. The Air Force has been the most concerned about the situation and reports a current shortage of about 1,100 engineers. Additionally, the Armed Forces report greater retention problems with officers in science and engineering disciplines. The Air Force, for example, reported that for the past 5 years the loss rate of engineers completing their initial 4-year active service obligation is twice that for other nonflying officers.

All of this is in contrast to the status of technical education in other countries, and the Soviet Union in particular. Since the Soviet Union launched a comprehensive campaign to upgrade its educational system 15 years ago, Russian schooling has taken a giant leap forward. Today, young Soviets graduate from secondary schools in much greater numbers than their American counterparts, and devote much more study to the hard sciences.

Consider these statistics. Each student in the U.S.S.R. must take the following compulsory courses to qualify for a secondary school diploma: 5 years of physics; 4 years of chemistry; 5½ years of biology; 5 years of geography; 3 years of mechanical drawing; 10 years of workshop training; and 1 year of astronomy.

In addition, Russian students are required to complete 5 years of algebra, 10 years of geometry, and 2 years of calculus. According to a National Science Foundation study of our own high school graduates, only 9.1 percent receive even 1 year of physics; 16.1 percent 1 year of chemistry; 45 percent 1 year of biology; and 17.3 percent 1 year of general science. In addition, the Soviets have raised their secondary school graduation rate from a scant 4.9 percent recorded in 1940 to 97.7 percent in 1978. By comparison, only 75 percent of all students in the United States complete high school.

Dr. Isaac Wirszup, a professor at the University of Chicago, and an expert on Soviet science education, stated that:

> The disparity between the level of training in science and mathematics of an average Soviet skilled worker or military recruit and that of a non-college bound American high school graduate, and an average worker in one of our major industries, or an average member of our all-volunteer Army, is so great that comparisons are meaningless.

In 1979, the Soviet Union graduated more than twice the number of scientists and engineers than did the United States, and almost five times as many engineering students. The United States ranks third behind the Soviet Union and Japan when comparing the total number of engineering graduates and also when considering the number of engineering graduates relative to the size of the total population. There is also evidence that the standard of undergraduate study in these countries is comparable to that of a master's degree program here in this country.

Another problem which will affect the long-term scenario is the large number of professors in these disciplines who are leaving academia for better paying jobs in industry. The report cites 2,000 engineering and 200 computer science faculty positions currently unfilled nationwide. This problem is not expected to improve because newly graduated baccalaureate students are similarly drawn away from pursuing advanced degrees and eventual teaching positions. Only 15 percent of the top engineering graduates enroll in graduate programs. The figure should be at least 35 percent. Those who do stay are non-U.S. citizens. A National Science Foundation study reports that if current trends continue throughout the eighties, almost 100 percent of all petroleum engineering graduate students will be foreign nationals and non-U.S. citizens will comprise over 50 percent of graduate students enrolled in most science and engineering fields. This situation creates concern for the Defense Department which must hire U.S. citizens and poses a technology transfer problem which troubles the military.

Finally, Mr. Chairman, attention must be given to the growing shortage of trained personnel in the skilled trades which threatens to undermine our national defense preparedness. In December 1980, a special panel of the House Armed Services Committee found after an extensive study that skilled manpower shortages are prevalent throughout the defense industry. One study indicated a shortage of 250,000 machinists in the next 5 years. The tooling and precision machinery industry could hire 60,000 journeymen now if they were available.

And listen to the projected shortages in other critical occupations by 1990: Impression diemaker, 42 percent; die designer, 34 percent; trim maker, 33 percent; and industrial engineering, 49 percent.

Between now and the year 1990, the U.S. Department of Labor estimates an annual average of 31,000 new skilled labor openings for machinists and machine operators. Yet only 2,300 new workers qualify for such jobs each year.

This situation has serious implications for our national defense. Our defense policy has long depended on technological superiority to counter the numerical superiority of the Soviet military. But, Mr. Chairman, our edge may be evaporating. We may soon find that our quality is no longer so superior that it compensates for the Soviet superiority in numbers.

So what can be done about this most serious problem? Unfortunately, I don't believe there is a single, simple solution. Those who look to Government alone to solve this problem will be disappointed. Rather, what we need in this area is a coordinated national effort. Government can help to focus national attention on the problems and provide some funding for training and education programs, and provide oversight. But the educational community, parents, and private industry, those that are closest to the problem and its solutions, must be full participating partners in this effort. We simply must not fail to tackle this problem now. We must upgrade the quality of education offered in our American high schools so that our graduates are not only better prepared for college, but also better prepared for vocational training programs leading to employment in the skilled trades. We must also be prepared to upgrade our physical facilities, our training equipment, and our laboratories.

Mr. Chairman, if we fail to meet this challenge and fall into a "technology gap," we will find our position as a world leader in agriculture and industry threatened, and also our national security endangered. There are those who say we cannot afford to take the steps necessary to redress this situation in today's tight budget climate. Mr. Chairman, I say that, in the interest of our economic well-being and our national security, we cannot afford not to do so.

[The attachment to Mr. Skelton's statement follows:]

Congressional Research Service
The Library of Congress

Washington, D.C. 20540

Insert 3B— [illegible]

UNITED STATES SUPPLY AND DEMAND OF SCIENTISTS AND ENGINEERS: EFFECTS ON DEFENSE RESEARCH AND TECHNOLOGY

PART I

CURRENT SITUATION AND FUTURE OUTLOOK

Edith F. Cooper
Analyst in Social Science
Science Policy Research Division

November 6, 1981

I. INTRODUCTION

The impact of the current and future supply of U.S. scientists and engineers on the Nation's economic productivity, among other issues, recently has become a major concern of many educators, industrial administrators, as well as Members of Congress. The current and future condition of the Nation's scientific and engineering manpower may affect significantly the country's scientific and technological capabilities to produce new and effectual innovations, economic competitiveness with other major industrial nations, and to the same degree, have an impact on national security in regard to military preparedness.

This report provides an overview of the status of the United States supply and demand of scientists and engineers. It discusses the latest college and university enrollments and degrees awarded in these areas of study, and the current demand to fill available scientific and engineering occupational positions in the workforce. The science and engineering enrollment and subsequent employment of foreign national students also are discussed. Information is provided regarding the impact of foreign nationals on the Nation's available supply and demand of scientific and engineering personnel. Information also is provided about science and engineering education, enrollments, and graduates of various other major countries in comparison with the United States. In addition, a ten-year projection is presented of the possible future supply and demand of U.S. scientific and engineering manpower.

A selected bibliography is included.

II. SUPPLY AND DEMAND OF SCIENTISTS AND ENGINEERS IN THE UNITED STATES

A. NUMBER OF COLLEGE GRADUATES IN SCIENTIFIC, MATHEMATICS, AND ENGINEERING FIELDS IN THE UNITED STATES

The chart below shows the number of bachelor's degrees awarded in 1979 and 1980 in the biological and physical sciences, mathematics, engineering, and the social sciences as a means of comparison.

TABLE 1

Total 1979 and 1980 Science and Engineering Bachelor's Degrees Awarded 1/

	1979	1980
Biological Sciences	48,846	46,370
Physical Sciences	23,207	23,410
Mathematics	11,806	11,378
Computer Science a/	8,769	11,213
Statistics a/	214	247
Engineering	62,375	68,893
Social Science	108,342	103,870

a/ Vetter, Betty and Eleanor Babco. Professional Women and Minorities: Manpower Data Resource Service. Washington, Scientific Manpower Commission, Feb. 1981. p. 126, 128, respectively.

1/ Provided by the National Center for Education Statistics by a spokesman during a telephone conversation on Oct. 19, 1981.

Undergraduate enrollments in engineering schools have almost doubled in seven years. [2] In fall 1973, there were 186,705 total full-time undergraduate engineering students enrolled in the United States. In fall 1980, the number had grown to 365,117, a 95.6 percent increase. [3] As a result, there appears to have been a notable increase in recent engineering graduates at the bachelor's degree level. The National Center for Education Statistics notes that, in 1979, 62,375 engineering students received bachelor's degrees, and in 1980, 68,893 bachelor's degrees were awarded to engineering students, a 10.4 percent increase. [4]

This growth has been attributed to the relatively large salaries being offered by industry to these graduates. [5] In petroleum engineering, as data from the Engineering Manpower Commission show, a recent graduate with a bachelor's degree may be offered a starting salary of $23,868 per year. [6] For chemical engineers with a bachelor's degree, $24,360 per year may be offered. [7]

---

[2] Peer, Elizabeth and Lucy Howard. Help Wanted: Newsweek, v. 96, Nov. 17, 1980. p. 87.

[3] Vetter, Betty, and Eleanor Babco. Professional Women and Minorities, p. 150. The 1980 figures were provided specifically by Eleanor Babco.

[4] Ibid., p. 139.

[5] Maeroff, Gene I. Today's Needs Threaten Future of Engineering. New York Times, Nov. 4, 1980. p. C1.

[6] Ibid.

[7] U.S. Graduate Salaries: Engineers Ahead. Nature, v. 292, Aug. 20, 1981. p. 663.

An aspect of the relative attractiveness to prospective students of science and engineering curricula vis-a-vis other curricula is educational counseling, an area on which little appears to have been written. One report, by the American Electronics Association, indicates that educational counseling for prospective engineering students seems to be inadequate. An example was given of the number of lawyers that graduated in 1979 (30,000) compared with the only 16,093 students who received electrical engineering degrees. The issue is not whether there should be a large number of lawyers graduating, but the possible lack of priority for career guidance relating to the field of engineering. 8/

B. SCIENCE AND ENGINEERING GRADUATES IN THE UNITED STATES PURSUING ADVANCED DEGREES

With industry offering large salaries to the science and engineering bachelor's degree recipients, these students are discouraged from seeking advanced degrees. 9/ In addition, some engineering university faculty members are leaving academia for jobs in industry for salaries that sometimes double the amount paid to them as engineering professors. 10/ Therefore, a shortage of faculty to train future engineers appears to be developing.

8/ American Electronics Association. Technical Employment Projections of Professionals and Paraprofessionals, 1981-1983-1985, Results. Palo Alto, Calif., May 1981. p. 181-182.

9/ Peer, Elizabeth, and Lucy Howard. Help Wanted: Engineers, p. 87.

10/ McCurdy, Jack. Faculty Shortage Perils Engineering School's Growth. Chronicles of Higher Education, v. 22, June 29, 1981. p. 1.

Pat Hubbard, Manager of Technology Training and Careers of the American Electronics Association, has stated that "nationwide, there are currently 2,000 unfilled engineering and 200 computer science faculty positions. Academic salaries are 25-30 percent lower than industry's and education cannot attract teachers from the small and available supply of Ph.D. graduates." 11/ As a procedure to attempt to improve the situation in California, Ms. Hubbard reports that a salary plan, approved by the California State College and University trustees, "to pay professors in business and engineering more than professors in other fields, so that college could compete with industry and other schools in hiring professors and reward merit, . . . met with strong opposition from two major faculty unions." The unions claimed that such a plan would start a "spoils system," be "demoralizing," and "would give preferential treatment to some professors." 12/

According to Daniel Drucker, President of the American Society for Engineering Education, "the need for engineering professors 'is going to get worse and the quality of instruction will continue to degrade.' . . . The problem is not just that too few engineers are going on to graduate school, but that 'far too many of the best graduates are not going on.'" Drucker estimates that "15 percent of the top engineering graduates [enroll] in graduate programs. The figure should be at least 35 percent," he concluded. 13/

11/ American Electronics Association. Technical Employment Projections, p. 181.

12/ Ibid.

13/ McCurdy, Jack. Faculty Shortage Perils Engineering Schools' Growth, p. 1, 5.

The table below shows the number of science and engineering graduates that received master's and doctorate degrees in 1979 and 1980.

TABLE 2

Total 1979 and 1980 Science and Engineering Master's and Doctorate Degrees Awarded

	1979		1980	
	Master's	Ph.D	Master's	Ph.D.
Biological Sciences	6,831	3,542	6,510	3,636
Physical Sciences	5,451	3,102	5,219	3,089
Mathematics	3,036	730	2,860	724
Computer Science a/	3,055	209	3,647 b/	240 b/
Statistics a/	532	165	99 b/	115 b/
Engineering	15,495	2,506	16,243	2,507
Social Sciences	12,887	3,360	12,181	3,225

a/ Vetter, Betty and Eleanor Babco. Professional Women and Minorities, p. 126, 128, respectively.

b/ Provided by the Scientific Manpower Commission during a telephone conversation on Oct. 19, 1981.

C. FOREIGN NATIONAL STUDENTS IN U.S. SCIENCE AND ENGINEERING FIELDS

1. Number and Percentage of Foreign National Students Studying Science and Engineering in U.S. Universities

It has been reported that currently there are about 286,000 foreign national students enrolled in U.S. colleges and universities. Enrollment data show that they are enrolling mostly in engineering, business, and management fields. 15/

There has been a particularly noticeable growth in recent years in foreign science and engineering graduate students in the United States. Petroleum engineering seems to be the area in which the most remarkable growth has occurred. If such trends continue throughout the 1980s, a recent National Science Foundation (NSF) report has stated, almost 100 percent of all petroleum engineering graduate students will be non-U.S. citizens and non-U.S. citizens will comprise over 50 percent of graduate students enrolled in most science and engineering fields. 16/ The table below compares U.S. science and engineering full-time graduate students with full-time foreign graduate students in the United States all enrolled in institutions granting doctorate degrees.

TABLE 3 17/

Comparison of U.S. and Foreign Full Time Graduate Students
In Doctorate Granting Institutions

Field of Science	Fiscal Year 1974			Fiscal Year 1979		
or Eng.	U.S.	Foreign	% Foreign	U.S.	Foreign	% Foreign
Petrol. Eng.	98	163	62%	117	250	68%
Elect. Eng.	5,249	2,401	31%	4,549	3,709	45%
Mech. Eng.	2,775	1,438	34%	2,754	2,241	45%
Comp. Sci.	2,957	819	22%	3,685	1,590	30%
Math & Appl. Math	7,082	1,305	16%	5,204	2,066	28%

Source: "Academic Science Graduate Enrollment and Support, Fall 1979," p. 48, 64. NSF Document 80-321.

15/ American Electronics Association. Technical Employment Projections, p. 183.

16/ National Science Foundation. Situation Report--Selected Federal Agencies' R&D Budgets. Report to Dr. M. Kent Wilson, Director OPRM. [By] Syl McNincy, Jr., Executive Assistant for Budget Policy, Washington, June 22, 1981, updated, July 6, 1981. p. 9.

17/ Ibid.

The Department of Defense (DOD) is greatly concerned about the increase of foreign national students, the NSF report notes, because the DOD must hire U.S. citizens. Due to significant increase in the number of foreign national students in some science and engineering fields, it is believed that in the near future, very few U.S. citizens in these fields will be available for hiring. In addition, "foreign students pose a technology transfer problem that is particularly troublesome for the military." 18/ As a result, DOD has reportedly devised a plan to implement a special fellowships program for study in specific science and engineering areas that are important to the Department. Funding for the program would be on about the $3.0 million level in fiscal year 1983 and increase to $5.0 million by fiscal year 1984 and fiscal year 1985. Eligible students would receive a $15,000 subsidy under the plan. 19/

2. Number and Percentage Graduating in Scientific and Engineering Fields

A common problem that seems to be the concern of both U.S. industry and U.S. universities is that "there is a dearth of American-born students pursuing advanced degrees in engineering, and in related research and technical fields. The results are a dwindling pool of U.S.-born talent from which

---

18/ Ibid.

19/ Ibid., p. 12.

[various] companies can draw their R&D staffs and universities can obtain faculty, and a troubling export of know-how to other countries." 20/

The following table provides the number of percentage of all engineering degrees awarded to foreign national students (F.N.S.) in 1980.

TABLE 4

Total 1980 Engineering Degrees Awarded
Foreign National Students, Number and Percentage By Level of Degree 21/

	Total all degrees	F.N.S.	Percent F.N.S. degrees
Bachelor's	58,742	4,895	8.33
Master's	17,243	4,512	26.17
Ph.D.'s	2,751	982	35.70
Total	78,736	10,389	13.19

3. Number and Percentage Pursuing Advanced Science and Engineering Degrees

According to data compiled by the Scientific Manpower Commission 22/ in fall 1980, a total of 44,335 full-time engineering students were enrolled in graduate school. Out of this number, 16,120 or 36.4 percent were foreign national students. Students enrolled part-time in graduate engineering school totaled 23,250, of which 2,690 or 11.6 percent were foreign nationals.

20/ Wanted: U.S.-Born Graduate Students. Chemical Week, v. 128, June 24, 1981. p. 44.

21/ Vetter, Betty and Eleanor Babco. Professional Women and Minorities, p. 144.

22/ Ibid., p. 150.

The National Research Council (NRC) reports that, in 1980, 46.3 percent of all doctorate degrees awarded in engineering went to non-U.S. citizens (1,149 out of a total 2,479 awarded; these data differ slightly from those in table 4 immediately above). 23/ Of those foreign national students, 299 (12.1 percent) hold permanent visas, while 850 (34.3 percent) hold temporary visas. 24/

In general, the report found the following regarding foreign national engineering Ph.D. recipients: 25/

- While the number of foreign citizens with permanent visas earning Ph.D.'s from U.S. universities has decreased by 38.6% from its peak year in 1972, the number of temporary visa holders has increased through the 1970's, reaching an all-time high of 3,632 in 1980;
- Foreign doctorate recipients are largely concentrated in science fields--about one-half of the engineering doctorates (46.3%) and one-third of the Ph.D.'s in the agricultural sciences (36.5%) in 1980 were foreign citizens;
- From 1960 to 1980, the geographic areas of Eastern and Western Asia were the sources for the largest number of foreign citizens earning doctorates in the U.S. In 1980, the Asian geographic areas accounted for nearly 44% of the total number of foreign doctorate recipients;
- In 1980, the three sources of financial support administered through the university--University Fellowship, Teaching Assistantship, and Research Assistantship--represented the primary support for 39.2% of the Ph.D.'s, with foreign citizens reporting greater dependence on support from these sources than their U.S. counterparts.

23/ National Research Council. Commission on Human Resources. Summary Report 1980: Doctorate Recipients from United States Universities. Washington, National Academy Press, 1981. p. 12.

24/ Ibid.

25/ Ibid., highlights (inside cover of report).

4. Number and Percentage of Foreign National Scientists and Engineers Employed by the U.S. Corporations and U.S. Military

The NRC reports that "for foreign citizens, the planned employment location following the doctorate is highly dependent on visa status--87.4% of permanent visa holders and 25.8% of the temporary group have firm commitments to remain in the U.S. for employment." 26/ The majority of those with temporary visas, however, 67.7 percent, indicated that they would be employed in another country. 27/ The remainder of temporary visa holders (6.5 percent), based on a diagram in the NRC study, 28/ probably did not report any particular location for future employment.

The type of position that most of the non-citizen Ph.D., recipients expected varied between the permanent and temporary visa groups. Of those holding permanent visas with firm employment plans, 45.8 percent were anticipating jobs in industry or business while only 41.8 percent indicated commitments to work in the academic environment. 29/ Of the temporary visa holders with definite employment plans 61.1 percent intended to work in academe.

Paul Morris, Jr., Head of Chemical Process Industries (CPI), who recruits for the Fox Morris Company of Wilmington, Delaware, has stated that "foreigners who decide to remain in the U.S. are forced by the marketplace

---

26/ Ibid., p. 21.

27/ Ibid.

28/ Ibid., p. 19.

29/ Ibid., p. 21.

to get higher degrees to compete with citizens for the same jobs. The majority are of a very high caliber, among the best their country has, and graduate in the top fifth of their class." 30/

In the academic area, Yatish T. Shah, professor and chairman of petroleum and chemical engineering at the University of Pittsburgh, has observed that "it is difficult to get top-quality American graduate students. We have to take foreign students to work on research projects at Pitt, and placement afterwards is a problem. Sixty to 70 percent of Pitt's full-time graduate enrollment in chemical engineering is foreign." 31/

Whether there are foreign nationals with degrees in scientific and engineering fields who seek employment in the U.S. military could not be determined for this report. A spokesman at the Scientific Manpower Commission suspects that data on such employees do not exist. 32/ A spokesman at the U.S. Bureau of Labor Statistics, Division of Employment and Unemployment Analysis, stated that such data are not collected because they would be difficult to obtain. 33/

30/ Wanted: U.S.-Born Graduate Students, p. 45.

31/ Ibid.

32/ Discussed during a telephone conversation with a spokesman at the Scientific Manpower Commission on Oct. 20, 1981.

33/ Discussed during a telephone conversation with a spokesman at the U.S. Bureau of Labor Statistics on Oct. 20, 1981.

5. Number and Percentage of Foreign National Scientists and Engineers That Return to Their Homelands

According to the report by the American Electronics Association, about one-third to one-half of all foreign national graduates of technical areas return to their native lands. 34/ The study points out, however, that there are benefits to having these foreign students in the United States. 35/ They are:

- [P]ayment of badly needed non-resident tuition dollars to universities and colleges;
- [I]ndirect assistance to help third world countries develop as graduates return home; and
- [G]raduates who do return to their native countries . . . remain sensitive to Western ideology and U.S. products within the international marketplace.

On the other hand, the report also lists some disadvantages:

- [I]n some cases U.S. students with adequate grade-point records are being excluded for college entrance in favor of foreign students with high records;
- [N]on-resident aliens--like residents--are putting a strain on academic resources of faculty, classrooms, and equipment which are already at the capacity and perhaps near-stress level; and
- . . . [W]e have a large number of senior faculty in our colleges today who are at or near retirement age. Who will teach the technical students tomorrow? Foreign students who cannot or do not wish to remain in the United States are lost as either teachers or as employees. 36/

34/ American Electronics Association. Technical Employment Projections, p. 184.

35/ Ibid., p. 183-184.

36/ Ibid.

D. CURRENT DEMAND

The current demand for science and engineering personnel has been assessed in the report coauthored by the National Science Foundation (NSF) and the Department of Education. This appraisal is based on such indicators as "unemployment rates; judgment by employers of the difficulties in filling job vacancies; changes in relative salaries for new entrants into particular fields; and the mobility of personnel within science and engineering fields, and between science and engineering and other fields." 37/ The following conclusions were drawn about the market conditions to date for science and engineering personnel:

- There are current shortages of computer professionals at all degree levels and tight markets 38/ at all degree levels in most engineering fields;
- University engineering schools and schools and departments which train computer professionals are unable to fill existing doctoral faculty positions, a condition that reflects the strong industrial market to these fields. Moreover, the American Society of Engineering Education reports that engineering and computer departments are also experiencing difficulties in retaining both their junior and senior faculty. In contrast, openings for Ph.D.'s in the academic sector are scarce in all fields of the mathematical, physical, biological, and social sciences;
- Employers in the industrial sector report that there are more than enough qualified physicists, chemists, mathematicians, and biologists. Trends in mobility data, however, suggest that the demand for chemists may be increasing faster than

---

37/ National Science Foundation and Department of Education. Science and Engineering Education in the 1980's and Beyond. Washington, U.S. Govt. Print. Off., Mar. 1980. p. 24.

38/ "Tight market" and "strong market" indicate that employers might have difficulties in finding qualified individuals to fill existing job openings.

the supply. Despite the adequacy of personnel in these broad fields, spot shortages (particularly at the Ph.D. level) are reported in several subspecialties, notably solid-state and plasma physics, optics, analytical and polymer chemistry, and toxicology;

- The Department of Defense reports problems in recruiting and retaining both civilian and military engineers because of the generally superior career opportunities in nonmilitary employment; and
- Many secondary schools report vacancies for teachers in mathematics and the physical sciences, despite ample supplies of people with bachelor's and master's degrees in these fields. 39/

An example of the difficulty in filling current job demands for technical personnel that is not directly related to supply is in the area of mathematics and physical science secondary teaching positions. A large number of unfilled teacher positions in mathematics and physical science at the secondary school level is reported to exist. 40/ The reasons for these unfilled positions are believed to be "a lessening in the attractiveness of science and mathematics teaching careers and from opportunities for more desirable employment outside of teaching. The supply of degree-holders with majors in these fields is high," the NSF/Department of Education study reports. 41/ Additional information that may be relevant to the mathematics/physical science teacher shortage is the fact that the average salary for beginning teachers with a bachelor's degree in mathematics was "73.1 percent of the average beginning salary offered in 1978 by private industry to bachelor's degree graduates in mathematics-statistics. In 1975-76, this ratio was 79.7 percent." 42/

39/ National Science Foundation and Department of Education. Science and Engineering Education, p. 24-25.

40/ Ibid., p. 49.

41/ Ibid.

42/ Ibid.

III. COMPARISON WITH SCIENCE AND ENGINEERING GRADUATES IN OTHER COUNTRIES

A. THE SOVIET UNION

In the Soviet Union, according to the NSF and Department of Education report, engineering education is considered to be the standard liberal arts education. 43/ SRI International reports that in 1976, the Soviet Union graduated almost six times as many engineers at the undergraduate level as the United States. 44/ Furthermore, the SRI study states that although "training is variable, at the better institutions the first Soviet degree in engineering represents a content level closer to our master's than to our bachelor's degree. In other sciences," it continues, "the Soviet Union produces fewer chemists and biologists than we do, about the same number of physicists/mathematicians, and a few more environmental scientists." 45/ On the graduate level, about 75 percent of the Soviet student enrollment is in science and engineering areas. In contrast, percentages for science and engineering master's and doctorate enrollment in the United States have been steadily declining since 1960. In 1974, graduate enrollment in these areas

---

43/ Ibid., p. 60.

44/ Ailes, Catherine P., and Francis W. Rushing. A Summary Report of the Educational Systems of the United States and the Soviet Union: Comparative Analysis. Final Report. Prepared for the National Science Foundation. Arlington, Virginia, SRI International, Mar. 1980. p. iii.

45/ Ibid.

was about 20 percent of the total U.S. enrollment. 46/ Statistics for 1976 show that graduate enrollment in science and engineering was about 14.4 percent of the total U.S. graduate enrollment 47/ and for 1978, 12.5 percent. 48/ See table 6, below which compares 1979 science and engineering graduates of the United States and the Soviet Union.

B. CHINA

Information about college graduates in science and engineering in the People's Republic of China (PRC) is not available, according to spokesmen at the PRC Embassy. 49/ It is known, however, that China has been a technologically underdeveloped country and has only recently begun to develop a technological capability. As discussed by Edward Teller, a physicist and senior research fellow at the Hoover Institute, the historical roots of China's underdeveloped status go back many centuries. The Chinese civilization was the first to make substantial progress in technology--"it developed printing,

---

46/ Ibid.

47/ Computed from table G-E-12, Enrollment for Master's and Doctor's Degrees, Selected Fields, 1969, 1972, and 1976, in the statistical report by Vetter, Betty, and Eleanor Babco. Professional Women and Minorities, p. 13.

48/ Provided by the National Center for Education Statistics during a telephone conversation with a spokesman on Oct. 20, 1981.

49/ Discussed with spokesmen at the PRC Embassy during telephone conversations on Oct. 20 and 22, 1981. Data specifically for graduates in science and engineering are not available. Data is obtainable only for all students who are enrolled in graduate school, in general, from the Minister of Education in Peking, China.

gunpowder, and rockets; ". . . revolutionized European agriculture by inventing "a harness designed so that horses could draw plows;" it also "developed the magnetic compass for navigation. Five hundred years ago," Teller states, "China was on its way to explore and enrich the world. Then a change occurred." In 1448, an imperial edict declared that China, the technological leader of that time, would "concentrate on traditional subjects--Confucian philosophy, calligraphy, and ceramics." As a result, "four hundred years later, when the West made contact, China had turned into a technologically underdeveloped country." 50/ Teller defines this situation as the "China Syndrome"--"the event begins with a rejection of science and technology; the effects are that the standard of living for the average man deteriorates and the nation becomes defenseless." He believes that the United States is experiencing this syndrome. 51/

In addition, Paul D. Hurd, Professor Emeritus in the School of Education at Stanford University in his as yet unpublished study, Science Education in the People's Republic of China, reports that during the period of the Chinese Cultural Revolution, 1966-1976, an "anti-intellectual" system of belief existed. In order to "restore educational and scientific vigor," he states, "new educational and science policies were announced in late 1977 and in 1978. The new policies called for rapid developments in scientific research, technology, and industrialization and a national reformulation of school and college science curricula that will make them

---

50/ Teller, Edward. Is U.S. Repeating a Chinese Mistake? Chicago Tribune, Section 3, Jan. 9, 1981. p. 4.

51/ Ibid.

supportive of national interests." 52/ Dr. Hurd also notes that the Chinese Constitution was rewritten and adopted, in 1978, to include policies concerning scientific education. Articles 12 and 13 in the constitution declares specifically:

> Article 12: The state devotes major efforts to developing science, expands scientific research, promotes technical innovation and technical revolution and adopts advanced techniques whenever possible in all departments of the national economy . . . .
>
> Article 13: The state devotes major efforts to developing education in order to raise the cultural and scientific level of the whole nation 53/

C. FRANCE

The engineering schools in France appear to be designed to attract the most talented students. There are over 150 schools in engineering that have usually 10 to 20 applicants for each available space. 54/ The "grandes ecoles" are considered to be the most prestigious engineering schools in France. These schools "primarily train professionals to serve the needs of the state and of society." Relatively small, their total enrollment is usually only about 500 students in each school. 55/ Admission to the

---

52/ Hurd, Paul D. Science Education in the People's Republic of China. Prepared at the Request of the Science Education Directorate of the National Science Foundation, Oct. 1981. 14 p. With appendices. Unpublished.

53/ Ibid.

54/ Engineering Our Future. Report of the Committee of Inquiry into the Engineering Profession. Sir Montague Finniston, Chairman. London, Her Majesty's Stationery Office, Jan. 1980. p. 214. This study is referred to as the Finniston Report and will be so called in this report.

55/ Trilling, Leon. Technological Elites in France and the United States. Minerva, v. 17, Summer 1979. p. 227.

grandes ecoles is very competitive, according to Leon Trilling, and usually draws only the elite. He also reports that, in 1977, there were a total of 37,000 students enrolled in engineering and applied science programs in France. 56/ In the ten leading grandes ecoles engineering schools, there are about 4,000 total students enrolled. Only 1,000 students are admitted annually for all of the ten leading engineering schools combined, out of about 13,000 applicants. 57/ In 1979, a total of 11,447 engineering degrees were awarded in France from 154 engineering schools. The graduating students basically would have received at least five years of training beyond the baccalaureat. 58/ Of the 11,447 engineering graduates, 7,026 graduated at the level equivalent to the U.S. master's degree. The remaining 4,421 included among them, the United States equivalent of undergraduate engineering students. 59/

D. WEST GERMANY

The basic secondary school education in West Germany seems to be so complete that students who specialize in such diverse areas as classics,

---

56/ Ibid.

57/ Ibid.

58/ The baccalaureat is an examination required before entrance to a university at the end of the French high school. The end of high school in France, however, corresponds to about the completion of two years of college in the United States.

59/ Provided by the French Scientific Mission by a spokesman in the office of the scientific attache, during a telephone conversation on Oct. 29, 1981.

mathematics, or modern languages may pursue a degree in engineering at the higher educational level, and thus compete with students who have a more technical background. 60/ There is a standard curriculum in West German schools that stresses science and mathematics for all students through the tenth grade. Once a student has reached the tenth grade and has maintained adequate grades (B, B+), the student may continue through the upper secondary schools--grades 11 to 13. 61/ Approximately 75 percent of graduates from the upper secondary schools go on to universities. Also, about one-third of these graduates seek degrees in science, engineering, or mathematics. 62/

The most current data available reveal that, in 1976, 1,569 post-graduate degrees were awarded to West German students in the natural sciences; 224 bachelor's degrees in mathematics and computer science; 11,241 bachelor's degrees in engineering, and 8,058 post-graduate engineering degrees. 63/

E. GREAT BRITAIN

The image of the engineer in Great Britain appears to be one of low estate. "Engineering education," reports Simon Watt, "because it ignores questions of economic philosophy and purpose, leaves engineers in a poor position to articulate the needs of the work they are responsible for.

60/ Engineering Our Future, p. 219.

61/ National Science Foundation and Department of Education. Science and Engineering Education, p. 59.

62/ Ibid., p. 60.

63/ Statistical Yearbook, 1978-79. Paris, France, the United Nations Educational Scientific and Cultural Organization, 1980. p. 573.

In consequence, engineers embrace a doggedly pragmatic and anti-intellectual image." 64/

Up to the late 1960's, according to the Finniston report, "most engineers obtained their formal education through part-time study or block release while they were working in industry." 65/ Less than one-fourth of engineers took full-time degree courses. In 1971, however, the Council of Engineering Institutions (CEI) declared that a degree would be necessary for all future "Chartered Engineers." 66/

Engineering degree-level courses are offered in Great Britain at 48 universities and university colleges, 28 polytechnics, and 12 other institutions. Some schools have 50 or even fewer students enrolled each year, while larger schools have over 600. Eighteen of the largest universities, formerly called Colleges of Advanced Technology, which graduate over 200 students per year, provide about 70 percent of the total output of engineers. In 1978, over 16,300 students were enrolled in engineering-related degree courses. In addition, about "11,000 students graduated in engineering and technology from U.K. universities, polytechnics and colleges, representing an increase over previous years." 67/

64/ Watt, Simon. Britain's Engineering: Shadow of the Past. New Scientist, v. 91, July 9, 1981. p. 92.

65/ Engineering Our Future, p. 81-82.

66/ Ibid.

67/ Ibid., p. 49.

F. JAPAN

According to Michael W. Kirst, a professor of education at Stanford University who recently visited Japan at the invitation of the Japanese Ministry of Education, "in the 1980s, the Japanese educational system is much better equipped that its U.S. counterpart to produce workers with the high levels of skill in math, science, and engineering that the economy of the future will require." 68/ The NSF/Department of Education report states that Japan's secondary school system emphasizes mathematics and scientific fields more than does the U.S. school system. Also, its mathematics instruction seems more advanced. Seventh, eighth, and ninth grade students are taught geometry; trigonometry is taught to ninth graders; calculus, probability, and statistics are offered in high school. 69/

Although the United States awards more college and university-level degrees per year than Japan because of a larger population, Japan bestowed 20 percent of all bachelor's and about 40 percent of all master's degrees to engineers. These figures have been found to be about stable for the past ten years. In comparison, about five percent of engineering degrees are awarded in the United States at each degree level. 70/

68/ Kirst, Michael W. Japanese Education: Its Implications for Economic Competition in the 1980s. Phi Delta Kappan, v. 62, June 1981. p. 707.

69/ National Science Foundation and Department of Education. Science and Engineering Education, p. 59.

70/ Ibid.

In 1976, Japan awarded 2,529 mathematics and computer science bachelor's degrees; 191 mathematics and computer science post-graduate degrees; 68,126 bachelor's degrees in engineering; and 6,216 post-graduate engineering degrees. 71/

G. SUMMARY

Available data (see table 5 below) show that for 1976, the United States had the largest number of graduates in all fields of academic study, followed by the Soviet Union, Japan, West Germany, and France. The Soviet Union, however, had, in total and relative to all graduates, the largest number of graduates in science and engineering, with the United States second in absolute number and last relatively. Japan was third in the number of science and engineering graduates, but second in the number of engineering graduates per se.

Data for 1979, as shown in table 6, available only for the United States and the Soviet Union, indicate that the United States continued to surpass the Soviet Union in the total number of graduates for all fields. The Soviet Union, however, continued to graduate more than twice the number in science and engineering than did the United States, and almost five times as many engineering students. In the physical, life science, and mathematics areas, the United States continued to award almost twice as many degrees as did the Soviet Union, but lagged behind in the agricultural sciences. The Soviets graduated over two times the number of U.S. graduates in this field.

71/ Statistical Yearbook, 1978-79, p. 560.

TABLE 5

1976 Science and Engineering Graduates: All Countries Discussed a/

	Total, All Fields	S&E Graduates	S&E Graduates As Percent of Total b/	Physical, Life Sci. and Mathematics	Engi.	Agri.
U.S. b/	997,500	164,400	16.5%	98,200	46,700	19,500
CHINA	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
FRANCE	175,384	54,221	30.9%	53,737	484 e/	N.A.
W. GERMANY	207,719	71,659	34.5%	49,738	19,357	2,564
G. BRITIAN	N.A.	N.A.	N.A.	N.A.	11,000 c/	N.A.
JAPAN	504,638	133,561	26.5%	30,182	89,673	13,706
U.S.S.R. b/	734,600	383,400	52.2%	46,300	280,400	56,700

N.A. indicates that data is not available.

a/ Statistical Yearbook, 1978-1979. Unless otherwise noted. Data only available for 1976.

b/ Received from SRI International during telephone conversation with staff member on Oct. 27 and 28, 1981.

c/ From the Finniston Report.

d/ Calculated from columns 1 and 2.

e/ This figure taken from the UNESCO Statistical Yearbook, 1978-79, is incorrect according to a spokesman at the French Scientific Mission during a telephone conversation on Oct. 29, 1981. In 1979, the most recent data available shows that there were 508 chemical engineering graduates alone, and about 2,500 electrical engineering graduates, the spokesman reported.

TABLE 6

1979 Science and Engineering Graduates:
United States and the Soviet Union a/

	Total, All Fields	S&E Graduates	S&E Graduates As Percent of Total b/	Physical, Life Sci. and Mathematics	Engi.	Agri.
U.S.	1,000,600	179,700	17.9%	93,600	62,800	23,200
U.S.S.R.	790,000	416,900	32.9%	49,800	306,800	60,300

a/ Received from SRI International during a telephone conversation with a staff member on Oct. 27, 1981.

b/ Calculated from columns 1 and 2.

The data in table 7 below 72/ also reveal that the Soviet Union had the largest total number of engineering graduates, plus the largest percentage of engineering graduates relative to its total population, while Japan ranked second, and the United States, third, in both categories.

72/ The data showing the number of engineering graduates in table 5 (column 5) differ slightly from those of table 7 (column 5), but are consistent enough for the broad conclusions suggested here.

TABLE 7

1976-1979-1980
Engineering Degrees Awarded
For All Countries Discussed a/

1976

	Bach. Degree	Master Degree	Doctor Degree	Post-Graduate	Total	Percent of Total Population
U.S. b/	38,774	16,021	2,791		57,586	0.27
CHINA	N.A.			N.A.	N.A.	N.A.
FRANCE e/	N.A.			484	484	0.0009
W. GERMANY	11,241			8,058	19,299	0.03
G. BRITAIN	N.A.			N.A.	11,000	0.01
JAPAN	68,126			6,216	74,342	0.67
U.S.S.R.	N.A.			N.A.	280,400 c/	1.09

1979

	Bach. Degree	Master Degree	Doctor Degree	Post-Graduate	Total	Percent of Total Population
U.S. d/	62,375	15,495	2,506		80,376	0.37
CHINA	N.A.			N.A.	N.A.	N.A.
FRANCE	4,421	7,026		N.A.	11,447	0.02
W. GERMANY	N.A.			N.A.	N.A.	N.A.
G. BRITAIN	N.A.			N.A.	N.A.	N.A.
JAPAN	N.A.			N.A.	N.A.	N.A.
U.S.S.R.	N.A.			N.A.	306,800 c/	1.16

(TABLE 7 cont.)

1980

	Bach. Degree	Master Degree	Doctor Degree	Post-Graduate	Total	Percent of Total Population
U.S. d/	68,893	16,243	2,507		87,643	0.38
CHINA	N.A.			N.A.	N.A.	N.A.
FRANCE	N.A.			N.A.	N.A.	N.A.
W. GERMANY	N.A.			N.A.	N.A.	N.A.
G. BRITAIN	N.A.			N.A.	N.A.	N.A.
JAPAN	N.A.			N.A.	N.A.	N.A.
U.S.S.R.	N.A.			N.A.	N.A.	N.A.

---

a/ Statistical Yearbook, 1978-79, unless otherwise noted.

b/ Vetter, Betty and Eleanor Babco. Professional Women and Minorities, p. 139.

c/ Received from SRI International during a telephone conversation with a staff member on Oct. 27 and 28, 1981.

d/ Received from the National Center for Educational Statistics during a telephone conversation with a staff member on Oct. 19, 1981.

e/ According to the French Scientific Mission, this figure is incorrect as previously stated in footnote e of table 5.

IV. TEN-YEAR OUTLOOK FOR U.S. SCIENCE AND ENGINEERING PERSONNEL

A. DEMAND

The U.S. Bureau of Labor Statistics (BLS) developed two sets of projections of the demand for scientists and engineers at all degree levels in 1990 for the NSF/Department of Education study. These projections are based on assumptions regarding economic conditions and Federal policy goals during the 1980s. The first projection (referred to as baseline assumptions) assumes that there will be a decrease in unemployment to 4.5 percent by 1990, and a yearly "increase in labor productivity to 2.4 percent by 1985-1990 above the current rate." Based on these assumptions, the BLS made the following projections concerning the demand for scientist and engineers in 1990: 73/

- . . . [T]he employment of scientists and engineers in science and engineering occupations and in all degree levels will grow by about 40 percent between 1978 and 1990;
- This growth would create about 180,000 new jobs in the mathematical, physical, life and social sciences, about 480,000 new jobs in the computer professions, and 250,000 new engineering jobs during the twelve-year period [1978-1990];
- . . . [T]he most rapid growth, about 110 percent, is projected for computer professions;

73/ Ibid.

- Employment of all engineers combined is projected to grow by less than 25 percent, with the most rapid expansion for mining (almost 50 percent) and petroleum engineers (40 percent);
- Estimated growth in all other major subfields [in engineering] ranges between 19 and 28 percent; 74/
- Among the sciences [occupational] growth is put at 40 percent for psychologists, geologists, statisticians, and economists;
- Occupations with projected slow growth include atmospheric scientists, physicists and astronomers, and mathematicians, all of which are projected at ten percent or less. 75/

The second set of BLS projections were based on three Federal policy goals -- (1) "a sharply augmented defense budget"; (2) "large-scale development of synthetic fuels"; and (3) "a balanced Federal budget." The effects that each policy goal would have on the demand for scientists and engineers will be discussed separately below.

> (1) A Sharply Augmented Defense Budget. [Under this supposition], defense expenditures [excluding payment of military personnel] rise by 14 percent, or $6 billion in 1972 dollars, between 1978 and 1990. The assumption of a more rapid expansion of 43 percent, or $18 billion in 1972 dollars, has a small effect upon projected employment [of scientists and engineers] except for aeronautical engineers . . . [R]equirements for aeronautical engineers would expand by about 40 percent over the twelve-year period . . . .; 76/

74/ Many computer professionals, the NSF/Department of Education report points out, receive their degrees from electrical engineering departments. Therefore, if demand for this particular group of computer professionals were combined with electrical engineering, employment in the electrical engineering field would probably grow at a faster rate.

75/ National Science Foundation and Department of Education. Science and Engineering Education, p. 27.

76/ Ibid.

(2) Large-Scale Development of Synthetic Fuels. To determine the impact of this assumption on the occupational demand for scientists and engineers in 1990, the BLS consulted with the Department of Energy. Subsequently, it created a theoretical program that called for the "construction and operation of new facilities for coal liquefaction and gasification and oil shale development." This hypothetical program would produce about three quadrillion BTUs. This would be "about three percent of the total energy supply, including imports, projected by BLS to be available in 1990, and equivalent to 1.4 million barrels of oil per day (MMBPD)." Based upon such a synthetic fuels program, the BLS suggests that there will be only a small impact upon science and engineering employment in 1990 and would not change their market assessments made under their first set of projections. 77/ The impact of a larger synthetic fuels program, (reportedly "a House-Senate conference synthetic fuels bill sets a 1987 goal of 0.5 MMBPD and a 1992 target of 2.0 MMBPD"), the BLS "assumed that existing technology would be used in production facilities installed over the next ten years." Additional

---

77/ Ibid., p. 28.

employment, therefore, would be for the building and operating of new plants, requiring only limited numbers of scientists and engineers; 78/ and

(3) A Balanced Federal Budget. With the assumption that the Federal Budget will be balanced by 1983 and continue to be so through 1990, the BLS predicts that this would have "no major effect upon projected 1990 science and engineering employment, since the assumed changes in fiscal policy would affect the economy as a whole and have relatively little effect on those industries with high concentrations of scientists and engineers." 79/

The demand for science and engineering graduates between 1978 and 1990, the report states, was determined from 1990 employment estimates. This demand would be for "trained but inexperienced personnel who would die or retire and to fill the new jobs created in the twelve-year period." Under both sets of BLS projections of the demand, "about 360,000 scientists and over one million computer professionals and engineers, or a total of about 1.4 million scientists and engineers would be needed to fill growth and replacement demand (excluding openings in academia.)" 80/

78/ Ibid.

79/ Ibid.

80/ Ibid.

B. SUPPLY

By 1990, the supply of scientists and engineers should be adequate to meet the demand in all fields except the computer professions, statistics, and industrial engineering according to the NSF/Department of Education report. 81/ There is a possibility of shortages in some areas of aeronautical engineering as well, especially if there is a rapid expansion of defense programs. 82/

The table below, prepared by the National Science Foundation and Department of Education, provides an overall view of the projections for the science and engineering labor market in 1990.

81/ National Science Foundation and Department of Education. Science and Engineering Education, p. 26.

82/ Ibid.

TABLE 8 83/

Projected Market for Scientists and Engineers in 1990 by Field and Level of Training

(all scenarios)

	Baccalaureates and Masters	*Doctorates*
Physical Sciences	Adequate	Adequate
Atmospheric	Balance	
Chemical	Adequate	
Geological	Adequate	
Physics and Astronomy ..	Adequate	
Engineering	Adequate	Uncertain
Aeronautical	Balance-Shortage[1]	(Possible shortages some fields)
Chemical	Adequate	
Civil	Adequate	
Electrical	Adequate	
Industrial	Shortage	
Mechanical	Adequate	
Metallurgical	Adequate	
Mining	Adequate	
Petroleum	Balance	
Other	Adequate	
Mathematical Sciences	Adequate	Adequate
Mathematicians	Adequate	
Statisticians	Shortage	
Computer Professions	Shortage	Shortage
Life Sciences	Adequate	Adequate
Agricultural	Adequate	Adequate
Biological	Adequate	Adequate
Social Sciences	Adequate	Adequate
Psychologists	Adequate	
Other	Adequate	
All Fields	Adequate	Adequate

[1] Shortage under expanded defense spending assumption only.

NOTE: "Adequate" indicates that projected supply exceeds projected dema indicates that projected supply is close to projected demand. "Shortage" indicate supply is less than projected demand. "Uncertain" is used for doctoral engineer projects an adequate supply in 1990 whereas BLS projects a shortage in 1985.
SOURCES: Bureau of Labor Statistics, National Center for Education Researc Science Foundation.

83/ Ibid. The U.S. Bureau of Labor Statistics projections regarding doctoral engineers differ from NSF projections as to whether there will be a shortage or an adequate supply in 1990. The BLS foresees a shortage.

There are several implications that have been drawn from these projections. They are:

- The number of new science graduates should widely exceed the number who will be able to find jobs in the disciplines in which they were trained;
- The projected excess of graduates over jobs implies many with science degrees will take employment not directly related to science and engineering;
- . . . Implied is a continued upgrading of the level of training of the technical labor force. Baccalaureates would fill jobs once held by high school graduates and doctorates would fill positions formerly held by those with less training often in positions unrelated to teaching or research and development; and
- . . . Projections indicate that for engineers with bachelor's or master's degrees, the labor market in 1990 should [have less favorable employment possibilities for scientists and engineers] than at any time since the early 1970s as a result of faster expansion in the supply of qualified personnel than in demand for their services. 84/

These projections, as explained in the NSF/Department of Education report, may seem optimistic because they are based on the assumption that colleges and universities will have the necessary capabilities to educate all qualified undergraduate and graduate level students who will be seeking various science and engineering degrees. 85/ Skeptics, however, suggest that this assumption may be unfounded, especially for engineering colleges because of "rising undergraduate enrollments, falling levels of Ph.D. production, and faculty shortages [which] indicate that these colleges may not

---

84/ Ibid.

85/ Ibid., p. 27.

be able to train all qualified applicants." 86/ "In this case," the study concludes, "there would be fewer engineers available in 1990 than the projections indicate, possibly resulting in continuing tight markets in most specialities and, perhaps, serious personnel shortages in a few of them." 87/

C. SUMMARY OF POSSIBLE SHORTAGES

The following table, prepared by the BLS and the National Center for Education Statistics (NCES), compares estimates of employment openings by occupation (the BLS contribution) with NCES projections of supply of bachelor's and master's degree graduates from 1978 through 1990 in each scientific and engineering field. The NCES predicts that between 1978 and 1990, there will be about 3.4 million graduates receiving bachelor's degrees in science and engineering, and 630,000 science and engineering master's degree recipients. 88/

86/ Ibid.

87/ Ibid.

88/ Ibid.

TABLE 9 89/

Comparison of Projected Job Openings with Projected Degrees in Science and Engineering 1978-1990

	Job Openings, 1978-1990 (in thousands) Scenario				Graduates, 1978-1990 (in thousands) Level	
	Baseline Assumptions	Accelerated Defense Spending	Synthetic Fuels Program	Balanced Federal Budget	Baccalaureate Degrees	Master's Degrees
Life and Physical Scientists						
Agricultural	16	16	16	16	145	36
Atmospheric	5	5	5	5	5	4
Biological	38	38	38	37	687	75
Chemical	65	64	64	65	178	26
Geological	22	22	23	22	67	18
Marine	2	2	2	2	10	3
Physics and Astronomy	11	11	11	11	43	19
Total	157	159	157	156	1,135	182
Mathematical Sciences						
Mathematicians	3	3	3	3	102	27
Statisticians	19	19	19	19	3	5
Total	22	22	22	22	105	32
Computer Professionals						
Programmers	280	282	280	280	NA	NA
Systems Analysts	221	223	221	221		
Other	38	39	38	38		
Total	540	553	539	537	110	47
Social Scientists						
Psychologists	76	76	76	78	459	111
Other[a]	100	102	101	99	658	59
Total	176	178	177	175	1,117	170
Engineers						
Aeronautical	24	30	26	24	28	NA
Chemical	22	22	22	21	92	
Civil	90	90	90	86	134	
Electrical	121	128	121	120	172	
Industrial	94	98	94	95	48	
Mechanical	80	95	88	80	171	
Metallurgical	9	9	9	9	16	
Mining	7	7	7	7	11	
Petroleum	11	11	11	11	14	
Other	59	64	59	59	115	
Total	528	564	534[b]	525	809[c]	196
Total all Fields	1,482	1,473	1,459	1,424	3,300	680

[a] Includes economists, political scientists, and sociologists.

[b] Includes 4,000 engineers who are not classified by field.

[c] Includes 15,000 engineering technology degrees not distributed by field.

NOTE: Estimates of openings do not include [illegible] employment. Totals may not add to totals because of rounding.

SOURCES: National Science Foundation, Bureau of Labor Statistics, and National Center for Education Statistics.

89/ Ibid., p. 29.

The comparisons indicate that there are likely to be large shortages of people with bachelor's and master's degrees in the computer professions and statistics. Large numbers of individuals, however, with mathematical training may be attracted to these fields, the NSF/Department of Education predicts, thus probably decreasing the projected shortage.

In engineering fields, as mentioned previously, industrial engineering may have fewer graduates than available job openings; and the fields of aeronautical engineering may experience a small deficit in 1990 if the defense program is accelerated. Nuclear engineering may have future shortages, according to the Department of Energy, because several universities are eliminating nuclear engineering departments and more are planning to do so. 90/

A study, sponsored by the Department of Agriculture concerning current and future supply and demand in occupations that may require agricultural or natural resources training, other than agricultural science, has found that in 1985, "there may be shortages of workers with training in several job categories such as agricultural engineering and food and agricultural chemistry." 91/

In general, the report concludes that for the overall engineering labor market in 1990, employers may have greater difficulties in locating qualified individuals to fill existing job openings than is indicated by the numbers in the table. 92/

90/ Ibid., p. 28.

91/ Ibid.

92/ Ibid.

ENGINEERING MANPOWER: A SURVEY OF THE NATIONAL PROBLEM AND THE PROBLEM IN THE DEPARTMENT OF DEFENSE

Prepared for the Honorable Ike Skelton

Paul Zinsmeister
Specialist in National Defense
Foreign Affairs and National Defense Division

December ~~11~~, 1981

INTRODUCTION AND BACKROUND

This paper is not a definitive study of the perceived shortage of scientific and engineering manpower confronting the U.S. as a whole and the Department of Defense in particular. It is, rather, a survey of the current situation at the national level and within the Department of Defense (DOD). Since the current discussion focuses almost exclusively on shortages of engineers, this paper treats only that problem.

It is safe to state that there is no "definitive" study of the precise nature of the engineer manpower problem. There is, however, widespread concern among industry, government, academe, and scientific and engineering professional societies that the problem could endanger U.S. world leadership in technology. Although the supply-vs-demand side of the issue may lack clarity, there is widespread agreement that [the] U.S. technical education is in trouble and needs correcting if the long-term manpower problem is to be solved.

While the engineer manpower problem is described in terms of numbers and quality, its scope is of vital national significance since it embraces both the economic wellbeing and national security of the U.S. Thus, a concerted national effort is needed to address what is clearly a national problem. Our survey indicates that while there is much concern, efforts at solutions appear fragmented (thus far).

The Department of Defense (DOD) has an interest in an adequate supply of engineers both from an in-house and national perspective. To illustrate: Almost 10 percent ($20 billion) of the FY 1982 DOD budget is for Research, Development, Testing and Evaluation (RDT&E). About a quarter of these funds will be spent on in-house RDT&E performed by DOD and other government agencies. The remaining three-quarters will go to civilian industry ($14 billion) and U.S. universities ($.7 billion).

It has been a long-standing tenet of U.S. defense policy to counter Soviet military superiority in numbers of men and equipment with technologically superior weapons and supporting systems. U.S. ships, planes, and tanks have become increasingly more sophisticated and reliant on high-technology. But there is general concern that whatever edge the U.S. and its allies have enjoyed is evaporating. John Collins, noted defense analyst with the Congressional Research Service, in his massive study of the U.S.-Soviet military balance concludes:

> U.S. technological superiority shows signs of perishability. The qualitative preeminence of deployed products is generally less pronounced than in the past, and in many instances has already disappeared. 1/

This view is shared by the prestigious International Institute for Strategic Studies (IISS). In its summary of the 1981-1982 military balance between the Warsaw Pact and the NATO Alliance IISS concludes:

> The numerical balance over the last 20 years has ... moved in favour of the East. At the same time the West has largely lost the technological edge that allowed NATO to believe that quality could substitute for numbers. 2/

1/ Collins, John, M. U.S.-Soviet Military Balance: Concepts and Capabilities 1960-1980. McGraw-Hill, 1980. p. 401.

2/ The Military Balance: 1981-1982. The International Institute for Strategic Studies. London. p. 123

Although defense has a vital claim on the national allocation of scarce engineers, so does the non-defense sector of the U.S. economy. Lester Thurow, noted economist from the Massachusetts Institute of Technology, warns that these competing demands will be unfavorable to the non-defense sector. He believes that defense spending will cause defense contractors to entice skilled persons away from civilian industry by paying higher wages. Even if wages were identical Thurow thinks the most highly qualified persons will tend to move into defense jobs because --

> [t]he military is willing to pay almost any premium to have a superior product. The civilian economy is not. As a result the most skilled technicians and scientists will move into defense. 3/

Since the defense and non-defense sectors of the U.S. economy have competing demands for the same resource it is necessary to describe the national engineer manpower problem as seen by the people who are working it. The next two sections will summarize the supply/demand problem and the education problem from the national perspective. Following that, a section will treat the DOD problem.

THE NATIONAL ENGINEER SUPPLY AND DEMAND PROBLEM

In general, the supply/demand problem for the decade of the 1980s has not not yet been fully sorted out. There is a plethora of data but, as one Congressional staffer familiar with the issue noted, there are no accredited numbers

---

3/ Thurow, Lester. How to Work the Economy. New York Review. May 14, 1981. p. 4.

that accurately define the supply/demand problem. Nevertheless, the general opinion seems to be that the U.S. is on the frontier of a broad expansion of requirements for engineers and other technical manpower.

The tendency has been to describe the supply/demand problem in universal terms when it appears that there are shortages in some engineer fields and not in others (some fields may, in fact, have a surplus of supply), and that the problem differs by degree, by region, and by industry. Dr. Leo Young, Director of Research and Technical Information, Office of the Under Secretary of Defense for Research and Engineering, is concerned over this situation. He thinks that the tendency to generalize the need for engineers and the concommitant tendency to generalize scholarship and fellowship assistance could have serious implications for the future. He cautions that the U.S. could find itself in the same situation as it was in the the early 1970s -- "with too many engineers of one type and not enough of another." 4/

The National Science Foundation (NSF), through its Division of Sciences Resources Studies, has conducted a survey of several hundred employers in order to clarify some of these questions. The results of this study are being evaluated. Preliminary results indicate severe shortages in the electronic, computer, and chemical fields.

The current and near-term demand for engineers is strong as evidenced by

---

4/ Paper based on a talk given by Dr. Young at a November 17, 1981 meeting convened by the Institute of Electrical and Electronics Engineers on the subject of "Engineering Manpower Supply and Demand -- Examining Relationships."

the competitive biding among industry for engineers. Leland J. Walker, President of the Accreditation Board for Engineering and Technology, Inc., reported that in 1981 students with engineering degrees represented 7 percent of all degrees conferred, yet they received 63 percent of all job offers. 5/ This kind of competition has caused sharp increases in starting salaries for engineers with B.S. degrees and no experience: for example, the Engineering Manpower Commission of the American Association of Engineering Societies, reported that the 1981 median starting salary had increased by 11.7 percent over its 1980 survey. 6/

The American Electronic Association's (AEA) recent survey of 617 member companies with 1980 sales of nearly $80 billion projected a need for 113,000 technical professionals over the five-year period 1981-1985. The AEA survey projected 55,000 requirements in the electronic and computer science fields. 7/ The AEA also estimates that 50 new electronic companies are formed each month in the U.S. 8/

5/ Testimony of Dr. Robert A. Frosch, President, American Association of Engineering Societies, to the House Committee on Science and Technology. [Unpublished] Oct. 6, 1981. p. 3.

6/ Ibid. p. 3.

7/ Memorandum from the Acting Deputy Secretary of Defense for Research and Engineering (Research and Advanced Technology) to the Under Secretary of Defense for Research and Engineering. White Paper on the Status of Scientists and Engineering Personnel in the United States: An Analysis of the Problem, Its Impact on DOD, and the Role of Defense in the National Arena. Sept 18, 1981. p. 1 of the White Paper.

8/ Ibid. p. 1 of the White Paper.

Dr. Frank Press, President of the National Academy of Sciences, testifying before the House Committee on Science and Technology predicted that the decade of the 1980s will "witness a second industrial revolution growing out of high technology." Dr. Press felt that "many mid-level and smaller industries" would need engineers to survive in such an environment. And, Dr. Press said, these demands "have never been adequately factored into projections of future needs for engineers." 9/

The Bureau of Labor Statistics (BLS) has projected an annual average of 93,000 job openings for engineers for the 1978-1990 time frame. The bureau estimated that 27 percent of these jobs would be the result of new growth and 73 percent would come from replacing death and retirment losses (23 percent) and transfers to other occupations (50 percent). During the same period, the average annual supply of engineers would approximate 77,000 for an average annual shortfall of about 16,000. 10/

9/ Testimony of Dr. Frank Press, President, National Academy of Sciences, to the House Committee on Science and Technology. [Unpublished] Oct. 7, 1981. p. 5.

10/ U.S. Dept. of Labor. Bureau of Labor Statistics. Occupational and Training Data, 1980 Edition. Bulletin 2052. Washington, U.S. Govt. Print Off., 1980. p. 55.

The BLS report estimated that approximately 81,400 engineering bachelor degrees would be conferred each year and, based on past experience, an average of 80 percent (about 65,000) of the graduates would enter engineering jobs. The remainder of the annual supply would consist of persons graduating in related fields such as physics and mathematics (7,000) an entering engineering fields and immigrant engineers (5,000).

A "deliberately optimistic" projection done by the Air Force nonetheless estimates a total shortfall of 114,000 engineers over the 10-year period 1981-1990. 11/

The National Science Foundation and the Department of Education (DOE) have estimated that there will be a gradual decline in the engineering manpower shortage until 1990, at which time the supply/demand situation will for the most part be in balance. 12/

As we indicated at the beginning of this section, the people CRS talked to who are "working the problem" agree that the data describing the scope of the supply-vs-demand issue lacks clarity. Perhaps the pending NSF study will be more definitive. 13/

11/ Briefing by Lt. Colonel Jim Graham, Office of the Deputy Chief of Staff for Personnel, United States Air Force.

12/ U.S. National Science Foundation and the Department of Education. Science and Engineering Education for the 1980's and Beyond. Washington, U.S. Govt. Print. Off., 1980. pp. 16, 27.
The report noted, however, that "the adequacy of PhD. engineers in 1990 is problematic" and that "shortages of computer professionals at all degree levels is expected to persist beyond 1990. p. 17.

13/ There is also the opposite problem of the effect military manpower requirements will have on the future supply of scientists and engineers. This problem is particulary important in view of the 15 percent drop in 18 year-old males forecast during the 1980s. This problem was the subject of a study by the Commission on Human Resources of the National Research Council. In its October 1981 report the Commission concluded: "military personnel requirements under less than major increases in force levels or mobilization conditions will not have a heavily negative effect on the output of scientists and engineers. Indeed, under some combinations of policy alternatives, military personnel policies might increase this supply."

From our perspective, perceived deficiencies in the U.S. education system (see below) appear to seriously fault long-term supply predictions.

Perhaps the bottom line on the supply/demand issue was drawn by Dr. Robert A. Frosch in his October 6, 1981 testimony to the House Committee on Science and Technology:

> ... while we can make extrapolating models which use the estimates made by the consumers of engineers, their employers and the parts of the economy in which they work, we can by no means be sure of the stability of these predictions in the face of actual unpredicted, and probably unpredictable, events. 14/

Dr. Frosch then concluded:

> We can only be sure, however, that if the society is to continue more or less in the nature of its past performance that there will be a continued strong demand for engineers. 15/

THE U.S. TECHNICAL EDUCATION PROBLEM

The deteriorating quality of U.S. technical education at the university and secondary school levels is cause for anxiety among those concerned over the engineer manpower problem. Perceived defects in U.S. technical education effect both the future numbers of engineers that can be graduated from university campuses, but, more importantly, the quality of those who enter engineering fields. Indeed, DOD's Dr. Leo Young believes that U.S. technical

---

14/ Testimony of Dr. Robert A. Frosch, President, American Association of Engineering Societies, to the House Committee on Science and Technology. [Unpublished] October 6, 1981. p.5.

15/ Ibid. p. 5.

technical education should concentrate on producing relatively small numbers of high quality and dedicated engineers. 16/

At a time when undergraduate enrollment in engineering and related technical disciplines is reported at record levels there is fear that the quality of instruction is deteriorating. 17/ A general shortage of faculty -- currently estimated at 8-10 percent of total U.S. engineering faculty positions -- and obsolete instructional equipment at many universities are considered the primary reasons for this situation. In his testimony to the House Science and Technology Committee, Dr. Press said that the equipment problem has existed for a decade and the Federal government had only recently "become involved in a cooperative effort" to replace "inadequate and outmoded equipment." He went on to say, however, that the trend toward reduced Federal spending has "for all practical purposes, aborted this effort." 18/

16/ Paper based on a talk given by Dr. Young at a November 17, 1981 meeting convened by the Institute of Electrical and Electronics Engineers on the subject of "Engineering Manpower Supply and Demand -- Examining Relationships." Also, informal discussion with Dr. Young on December 9, 1981.

17/ Reportedly, engineering enrollments have increased by approximately half since 1975. Undergraduate engineering enrollment at the San Diego campus of the Unversity of California rose from 7 percent of total enrollments to 20 percent. Samuelson, Robert J. Schools Shrink, Need For Engineers Grows. Washington Post, December 15, 1981. p. D 7/10.

There is also concern that many institutions may be reaching their capacity to absorb undergraduate engineering enrollments. In his article Samuelson reported that the University of Illinios (Champaign-Urbana) is reducing enrollment 20 percent to relieve overworked faculty and crowded laboratories.

18/ Witness statement of Dr. Press. p. 3-4.

~~technical~~ education should concentrate on producing relatively small numbers of high quality and dedicated engineers. 16/

At a time when undergraduate enrollment in engineering and related technical disciplines is reported at record levels there is fear that the quality of instruction is deteriorating. 17/ A general shortage of faculty -- currently estimated at 8-10 percent of total U.S. engineering faculty positions -- and obsolete instructional equipment at many universities are considered the primary reasons for this situation. In his testimony to the House Science and Technology Committee, Dr. Press said that the equipment problem has existed for a decade and the Federal government had only recently "become involved in a cooperative effort" to replace "inadequate and outmoded equipment." He went on to say, however, that the trend toward reduced Federal spending has "for all practical purposes, aborted this effort." 18/

16/ Paper based on a talk given by Dr. Young at a November 17, 1981 meeting convened by the Institute of Electrical and Electronics Engineers on the subject of "Engineering Manpower Supply and Demand -- Examining Relationships." Also, informal discussion with Dr. Young on December 9, 1981.

17/ Reportedly, engineering enrollments have increased by approximately half since 1975. Undergraduate engineering enrollment at the San Diego campus of the Unversity of California rose from 7 percent of total enrollments to 20 percent. Samuelson, Robert J. Schools Shrink, Need For Engineers Grows. Washington Post, December 15, 1981. p. D 7/10.

There is also concern that many institutions may be reaching their capacity to absorb undergraduate engineering enrollments. In his article Samuelson reported that the University of Illinios (Champaign-Urbana) is reducing enrollment 20 percent to relieve overworked faculty and crowded laboratories.

18/ Witness statement of Dr. Press. p. 3-4.

Many universities have been required to increase class size to accommodate the larger numbers of undergraduate engineering students and faculty shortages. The combination of larger classes and fewer faculty is perceived as not only lowering the quality of instruction but, because of heavy student demands on professors, lowering the perception of the quality of academic life as well. The chief cause of the faculty shortage is attributed to high salaries offered by industry which tend to draw engineering students away from further academic pursuits and teaching careers. The faculty shortage at some campuses has been partially alleviated by hiring foreign engineers. There is a question, however, as to whether the use of foreign professors provides long-term or only temporary relief. Dr. Frosch told the House Science and Technology Committee that not much is known about the proclivity of foreign engineers to remain permanently in the U.S. or to return at some time to their homelands. Moreover, there is some concern about the effect cultural and language differences have on the quality of instruction and student motivation. 19/

Besides the near-term technical education problem, Dr. Press warns of an "impending crisis" in the next decade because of the widespread deterioration of mathematic and science education in U.S. secondary schools. 20/ In contrast to the U.S., the major industrial countries of Japan, West Germany and

---

19/ Witness statement of Dr. Frosch. p. 4. Dr. Young of DOD said that although he considered foreign engineers to be generally highly qualified, he was concerned about their ability to motivate undergraduate students.

20/ Witness statement of Dr. Press. p. 10.

the Soviet Union place strong emphasis on mathematic and science instruction for their youth. Without major improvements in the mathematics and science programs at the secondary school level, Dr. Press believes that U.S. world leadership in technology is in jeopardy.

There is considerable activity underway among industry, educators, and the many engineering professional societies, to restore the quality of engineering instruction in the U.S. To illustrate:

-- Exxon has announced a $15 million grant to 66 schools to provide living expenses to graduate students and to supplement faculty salaries.

-- In January of 1982, the American Society of Mechanical Engineers along with other engineering societies will be conducting an action forum with participants from government (including the military) and industry.

-- The National Research Council, the operating arm of the National Academy of Science and the National Acadmey of Engineering, has been engaged in wide-ranging study of the engineer manpower problem.

-- Eight U.S. corporations (AT&T, du Pont, Exxon, General Electric, General Motors, General Telephone & Electronics, IBM, and Union Carbide) are sponsoring a two-year project to solve the engineering faculty shortage.

-- A National Engineering Action Conference with representatives from academia, industry, professional societies, and government will be convened in April 1982.

THE ENGINEER MANPOWER PROBLEM IN THE DEPARTMENT OF DEFENSE

DOD's requirement for engineers is unique in that the Department uses both civilian and military engineers. Moreover the DOD is not, per se, just one employer -- each of the military departments and separate DOD agencies compete among themselves for engineers.

This section discusses military engineers first and civilian engineers second. 21/

Military. The Air Force has been the most concerned of the services about shortages of engineers. For the past 2-1/2 years Air Force personnel managers have been aggressively pursuing measures that would relieve shortfalls. Neither the Army or the Navy have been as acutely concerned. This does not mean that only the Air Force has problems in filling engineer requirements; it probably is more indicative of differences in personnel management concepts and priorities among the services. Nonetheless, it is significant that only the Air Force plans to use the recently enacted continuation pay authority for scientist and engineer skills in critically short supply. 22/

21/ This section is based on data supplied by each of the military departments and transmitted by letter of November 27, 1981 from the Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics) and through informed discussions with persons within DOD who were knowledgeable on the subject.

22/ In general, the Uniformed Service Pay Act of 1981 (P.L. 97-60) provided, among other things, authority for each military service to pay continuation pay to officers serving in scientific and engineering skills determined to be critically short of requirements. The law authorizes payments of up to $3,000 for each year of service such officers agree to serve on active duty. The Air Force actively sought this authority and plans to pay it to electrical engineers.

The Army stated in its response to CRS that it was experiencing shortages in the "scientific and engineering fields," but the "gravity of the problem is not as acute as the Air Force or the Navy." The Army has, however, undertaken an "extensive" study to determine the technical disciplines that must be procured at the entry level (i.e., newly commissioned officers) to better support its long-term requirments for engineers and other technical specialities.

The Navy, in its response, did not volunteer an evaluation of its current or projected manning status in military engineers. We were told informally that the Navy's priorities have been focused on meeting its officers requirements in other specialties. The Navy has, for example, been heavily engaged in resolving shortages of nuclear qualified officers. 23/ CRS was also told that the Navy is beginning to examine billets that require specific technical disciplines in order to better assess requirements for officers to fill these billets.

The Air Force reported that it is currently about 1,100 engineers short of requirements but it would achieve full overall numerical manning of engineers in the "FY 84-85 time frame." This prediction however, was hedged with conditions: that is, numerical requirements would be met if (1) losses of engineers with

---

23/ The Navy has a continuing problem in attracting and retaining nuclear-qualified officers to man its nuclear-powered ships and submarines. The Navy is critically short of such officers and maintains 100 percent manning of its nuclear-powered submarines by "over-touring" (i.e., keeping officers on sea duty longer than desired) and by using more junior officers than desired. Congress has authorized the Navy to pay continuation pay to such officers as a recruiting and retention incentive.

4-11 years of service do not exceed 10-12 percent a year; (2) production of engineers from universities and other sources achieve at least 75 percent of expected totals; (3) industry does not bid up incentives too significantly; (4) growth in Air Force requirements for military engineers does not exceed 3 percent annually; and (5) the economy does not "boom."

Even though the Air Force expects to satisfy its numerical requirements, it anticipates two significant problems: its engineer force will be lacking in experience since over 50 percent will be lieutenants; and it will continue to be short of electrical engineers. 24/

In the aggregate, the Reserve Officer Training Corps (ROTC) supplied about 57 percent of the 7,938 officers with scientific and engineering disciplines who entered the armed forces in FYs 1980 and 1981. Military academies supplied about 29 percent and other sources (i.e., officer candidate programs, and voluntary recall of reserve officers) contributed the remaining 14 percent.

Accessions from these sources varied significantly among the services. Army data showed that for FYs 1980 and 1981, 73 percent of the total number of officers accessed with scientific and engineering degrees was through ROTC; comparable figures for the Air Force and Navy were 44 percent and 40 percent, respectively.

With respect to the military academies, data for the same two fiscal years showed that 43 percent of the Navy's input of scientific and engineering

---

24/ The Air Force reported that it is about 20 percent short of its requirement for electrical engineers, which constitute 35 percent of its total requirement for engineers.

officers came from the Naval Academy; the figures for the Military Academy and Air Force Academy were 26 percent and 12 percent, respectively. The percentage of accessions from other sources were: Army, 1 percent; Navy, 17 percent; and Air Force, 44 percent.

Because the military services view ROTC is a productive source for officers with engineering and other technical disciplines, they are expanding their ROTC scholarship programs. In 1980, Congress authorized the Army an additional 5,500 ROTC scholarships for a maximum total of 12,000. The recently enacted Uniformed Services Pay Act of 1981 authorized 3,500 more ROTC scholarships (for a maximum of 9,000) for the Air Force and 2,000 more (for a maximum total of 8,000) for the Navy. Each service is planning annual incremental expansion of its scholarship programs, provided funds are appropriated by Congress.

The Air Force adopted a policy in 1979 that 85 percent of its ROTC scholarships must be awarded to students pursuing scientific, engineering, and technical degrees. The Air Force expects its ROTC program to yield 473 engineering graduates in FY 1982 and 600 in FY 1983.

In 1976, the Navy established a goal that 80 percent of its ROTC entrants would be pursuing majors in the technical disciplines. The Navy reported it was having no problems in meeting this goal.

The Army has not yet established a similar policy with respect to the award of ROTC scholarships. The Army indicated, however, that it plans to dedicate some of its additional ROTC scholarship spaces to students pursuing scientific and engineering degrees as determined by the results of its requirements study above.

In general the loss of officers in the scientific and engineering disciplines tend to be above the norm. For example, the Air Force reported that for the past five years the loss rate of engineers completing their initial four-year active service obligation is twice that for other non-flying officers -- 33 percent versus 16 percent. Likewise, the loss rate for engineers with 4 to 11 years of service has averaged about 12 percent. This compares to 8 percent for other non-flying officers. 25/

Recent raises in basic pay averaging 11.7 percent in FY 1981 and 14.3 percent in FY 1982 plus a host of other compensation improvements enacted by Congress in the last two years should have a positive effort on retaining engineers. Of course, other individual considerations besides compensation -- e.g., job satisfaction, advancement opportunities, disposition (and that of the spouse) toward military service -- also affect proclivities to continue a military career or seek civilian pursuits.

In the final analysis, the major determinant in the ability of the military services to attract and retain engineers in a volunteer recruiting environment (i.e., no draft) will depend largely on private sector demand as well as the capability of the U.S. education sytem to produce engineers.

Civilian. The DOD employs substantial numbers of civilian engineers. Office of Personnel Management statistics for 1980 show that the DOD employed

---

25/ The Army provided extensive data indicating a similar experience as that of the Air Force. The Navy said it does not track retention data by technical background.

61 percent (53,712) of all engineers employed by the Federal government. The same data revealed that the Department of the Navy was the largest employer of DOD civilian engineers: 44 percent of the DOD total.

The Air Force reported that 57 percent of its present civilian vacancies are for engineers (in raw numbers, about 1,700). The Navy has similar problems; In 1980 the Navy reported it needed to hire 1,950 engineers at the entry level (GS-5 and GS-7) but filled only 53 percent of its needs. A sample of Navy entry-level recruiting results for certain engineer specialties for the 12-month period May 1, 1979 to May 1, 1980, ranged from a high of 76 percent for civil engineers to a low of 21 percent for electronic engineers. The Air Force confirms an acute problem in hiring electronic engineers: 40 percent of its vacancies are for engineers in this field.

DOD officials point to "money" as the chief culprit for the poor recruiting results. March 1981 data compiled by the Navy show that average annual Federal salaries paid its engineers lag behind wages paid private sector engineers by $3,000 to $6,000. The rigidity of the Federal pay structure and pay caps are cited as the main reasons for the unfavorable pay comparisons. 26/ A study released in October 1981 on recruiting, retention, and utilization of civilian engineers in the Joint Logistics Commands (JLC) (employers of nearly 38,000

26/ CRS learned that the Office of Personnel Management (OMB) ruled that "special pay" civil service employees -- in this instance, engineers -- would receive a 1.6 percent pay raise instead of 4.8 percent granted other General Schedule employees. The DOD appealed the decision but OMB so far has not changed its position.

engineers) said that "the most frequently stated advice from college placement officials to federal employers was 'pay more money'...." 27/

Retention of qualified engineers is also a problem. A September 18, 1981 DOD "White Paper" on the status of manning of engineers, scientists, and other techincal personnel throughout the DOD noted that "... highly qualified scientists and engineers at both the journeyman and middle management levels are leaving at an alarming rate. 28/ The White Paper and JLC study also noted a substantial portion of DOD's civilian scientific and engineer force is or soon will be eligible to retire. For example, the White Paper stated that over 1/3 of the engineer losses in Navy Research and Development Centers over a "recent 18-month period" were through retirement. The JLC study reported that by 1985, 19 percent of JLC engineers will be eligible to retire. 29/

27/ U.S. Dept. of Defense. Joint Logistics Commanders [&] Joint Panel on Civilian Personnel Management. Civilian Engineer Recruitment, Retention and Use Throughout the Joint Logistics Commands. Washington D.C., Oct. 30, 1981. p. 5. DOD acknowledges that other factors such as inferior laboratory facilities and equipment and lack of opportunities for growth and advancement can also adversely effect retention of highly qualified engineers.

28/ Memorandum from the Acting Deputy Under Secretary of Defense for Research and Engineering (Research and Advanced Technology) to the Under Secretary of Defense for Research and Engineering. White Paper on the Status of Scientific and Engineering Personnel in the United States: An Analysis of the Problem, Its Impact on DoD, and the Role of Defense in the National Arena. Sept. 18, 1981. p. 4 of the White Paper.

29/ U.S. Dept. of Defense. JLC study on engineers. p. 7.

In order to make civil service pay more competitive with private sector pay in recruiting engineers as well as other skills in short supply in DOD or other Federal agencies, the Navy has proposed legislation that would authorize the payment of a "recruiting bonus." The bonus, which would be administered by the Office of Personnel Management, would be in an amount that would make up the difference between starting salaries paid by the private sector and starting salaries permitted by Federal pay scales. The Navy also was granted authority to conduct a five-year demonstration study that experiments with different kinds of pay schemes. 30/

The DOD acknowledges that there has been "little unified policy-level commitment and action" toward solving its problem of recruiting and retaining civilian scientists and engineers. 31/ To that end, the Office of the Under Secretary of Defense for Research and Engineering has established a Personnel and Manpower Working Group. This group is tasked to arrive at a common understanding of the problem, establish a role which DOD should play with respect to the national problem, and achieve a consensus on approaches to solving its internal problem. The group will concentrate initially on the problem as it pertains to civilian scientists and engineers employed in DOD laboratories. ~~will concentrate initially on the problem as it pertains to civilian scientists and engineers employed in DOD laboratories.~~

30/ DOD White Paper. p. 5.

31/ DOD White Paper. p. 5.

Mr. SIMON. Thank you very much for your testimony. It emphasized particularly security aspects, and you mentioned the Soviet Union.

Let me just mention the other area where we have major problems, where I will have at least one amendment to this bill, and that is with foreign languages. In the Soviet Union you start either in the first grade or fourth grade, wherever you live, and you go from there. Secretary Weinberger has now spoken several times about the problems that our Armed Forces face in this area. Former Deputy Director of the CIA, Adm. Bobby Inman, I am sure you know, his words literally were, "The United States is creating a major, long-range security hazard for this country by creating problems in foreign languages," and the military intelligence agencies have testified before our Committee that we have a major problem. But you emphasize a very real problem that we have and we appreciate your testimony.

Mr. SKELTON. If I may respond, Mr. Chairman, to your comments, I think they're right on point. Not only from one point of view but from a national defense point of view, it is very necessary I think for us to become more bilingual and trilingual much more than we are now.

Also in the area of trade, we find ourselves speaking English when those who wish to trade with us come to our country and speak English very well. The proportion of the Japanese who trade with us speak English far greater than those of us who speak Japanese. Consequently, it gives a trading edge as well, which is an economic edge.

Mr. SIMON. It's pretty hard to sell if you can't speak the language of your customer.

Mr. SKELTON. It's pretty hard; that's right.

Mr. SIMON. Mr. Perkins.

Chairman PERKINS. I have no objection to my colleague's amendment, but I personally feel that given the situation that confronts the country today, science and math is more important. From my own experience in World War II, I make that observation.

After the war was over I had a chance to visit dozens of schools in Germany. All of those youngsters in the elementary, secondary grades could speak fluent English. It was just amazing.

I don't know how far they followed it up after World War II, but I'm just telling you they could speak the English language, fifth, sixth, and seventh grade youngsters, during the World War II years, 1944 and 1945.

The original National Defense Education Act addressed the need for modern foreign languages, but we have not concentrated on it like we should have. Perhaps we did not conduct the oversight that we should have after we enacted the National Defense Education Act. Then the Act was expended to cover the whole waterfront, and that's where we fell behind on some of the things that we should have concentrated more on, like the modern foreign languages and math and science. So we see ourselves in a position today where we have got to make up that lost ground, to put it bluntly. Naturally we want to try to do it.

Mr. SIMON. Thank you.

Mr. Bartlett.

Mr. **Bartlett**. Thank you, Mr. Chairman.

Mr. Skelton, we very much appreciate your testimony and the information that you provided to us, particularly on national defense issues and how this relates to national defense.

I was particularly impressed and wondered if you would elaborate—I was particularly impressed by your attention and your focus on the fact that, in fact, there is no one solution to this problem, that for Congress to just simply say "Congress should pass a bill and set the national priority," I know in my area and in yours I would suspect that school districts and universities and community colleges and private industry has figured out over the last several years that this is a national priority and the country is making it a national priority, and Congress and the Federal Government should do its part, but our part should be that of a stimulator and an enticer and not a magic wand.

I wonder if you would comment on that.

Mr. **Skelton**. Yes. Thank you, Mr. Bartlett, for your comments.

I do have a thought and a recommendation. As a matter of fact, I introduced legislation last year along this line, to establish a commission that would have a 30-month existence and would make a midterm final report, a commission composed of Government, which would also be the Department of Defense, private industry and education, as to first how serious the problem is and then what might be done to follow through and help close the so-called technology gap that I have described.

All three areas are going to have to have input into this, all three—private industry, Government, and the educational community. All three are going to have to do something.

I would hope that this committee would take a look at the proposal that I have introduced and incorporate either all of it or part of it to this end, because we have to take the first step and the first step is to find out how serious it is through the eyes not only of the Department of Defense, which I have already given you, but through the eyes of the educational community and through the eyes of the industrial or private sector of our nation.

I would urge that as part of your consideration today, Mr. Bartlett.

Mr. **Simon**. Mr. Miller.

Mr. **Miller**. I have no questions, Mr. Chairman.

Mr. **Simon**. Mr. Craig.

Mr. **Craig**. No.

Mr. **Simon**. Mr. Petri.

Mr. **Petri**. No questions.

Mr. **Simon**. Mr. Gunderson.

Mr. **Gunderson**. No.

Mr. **Simon**. We thank you very, very much.

Mr. **Skelton**. Mr. Chairman, I have already delivered the Library of Congress study and report to which I referred, and I would ask that it also be incorporated.

Mr. **Simon**. It will be incorporated in the record.

Mr. **Skelton**. Thank you so much.

Mr. **Simon**. We thank you very much for your testimony.

We now are pleased to have another colleague who has been a leader in the whole science and technology area, our colleague from California, Congressman George Brown.

STATEMENT OF HON. GEORGE E. BROWN, JR., A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. **Brown**. Thank you very much, Mr. Chairman. I appreciate the opportunity to be here this morning. I should like to comment that I served on this committee 20 years ago under the able tutelage of Chairman Perkins and it is a pleasure to be back before the committee again this morning.

I also would like to take note of the fact that you, as the chairman of this subcommittee, are in a position to bring about some of the linkages or couplings that are so important in approaching this subject, because of your assignment to the Committee on Science and Technology, and I want to commend you for the interest and leadership that you have given in this effort to strengthen the national posture with regard to education.

I have come to the conclusion myself—and I think it has been reiterated by other witnesses—that there is no single solution to this. It is going to have to be approached cooperatively, both in the Congress and in the country as a whole. We cannot solve the problems of the country as a Congress or as a Federal Government. We can give constructive leadership and guidance, and this is what we should be doing.

I noted, for example, your comments, Mr. Chairman, in earlier hearings on your legislation about some of the inadequacies of the approach of the National Science Foundation in the past, and I agree with that. It is a mistake to think that the National Science Foundation can solve the problems of science education in this country. It breaks down in many important ways, as you have indicated. It does not reach the bulk of the educational activities going on in the country, particularly that going on in the schools which serve the poorer students, the poorer States. It tends to focus on the prestige institutions of the country, the ones that are doing preeminent science, and this is worthy and very important. But the key problem today is creating the linkages between those institutions and the world class research that they're doing and the world class scientists that they have and the bulk of the people in this country who need to move into a new technological age, which we frequently refer to today as the "New Information Age", which is——

Chairman **Perkins** [presiding]. I cannot refrain from complimenting the gentleman. We cannot win this battle starting at the tip of the iceberg, just as you are so clearly stating today. We have got to reach down. The National Science Foundation was created for top level research, and it has done a wonderful job. But still, we have got to bring science into the classrooms where we have disadvantaged youngsters and let all young people have the opportunity to study these areas. Some of these students may make great scientists, but we have not given them the exposure.

Go ahead, George. Excuse me.

Mr. **Brown**. Thank you for that comment, Mr. Chairman.

What I seek to emphasize in my statement—and I will go through it quickly—is the need for a cooperative approach to this in which we utilize all of our resources to create that posture of leadership which this country so badly needs.

I am on the Science Committee today. I am concerned about the support that is directed to science and science education, through that committee. I am also on the Agriculture Committee and I chair the subcommittee that deals with agricultural research, with agricultural education and extension. I am concerned about the quality of that activity, also, and will be working intensively to insure that we upgrade and improve the level of knowledge, training, education available to the rural population of this country.

But again, I emphasize that we have to look at this picture as a whole, what is good for the country and how we can work together in achieving that, and I know we have the capability of doing that here in the Congress.

When we talk about the crisis in mathematics and science education, I think the underlying concern is that we have not been properly training and educating the American public and workforce for life in a technological economy and society. As President Reagan pointed out in his State of the Union address, the education and training needs of our society are changing as we move to an economy based more heavily on services and information. While improved mathematics and science education is an important first step in meeting these new educational needs, the real need is for improving our national technological literacy. In other words, we're talking about changes that involve the whole society.

Technological literacy refers to the foundation of skills required for living and working productively and humanely in a technological age. One of the important skills required to be technologically literate is the ability to use and control new technologies, such as computers and word processors. This requirement applies not only to those who are students today, but also to adults and even to Members of Congress.

Our children are our future, but adults will provide the transition to the technological society. Even more important than the ability to use or program one of today's computers is the ability to continue learning and adapting throughout one's life. As the rate at which new technologies are introduced continues to accelerate, the high technologies of today will be replaced by even higher technologies of tomorrow. Therefore, we need to concentrate on creating a foundation of skills upon which more specific training needs can be built.

The education and training needs of our adult population are critical. This reminds me, Mr. Chairman, that the first bill that I think I introduced in that 88th Congress 20 years ago dealt with adult education, and I know that was in part inspired by the work which you had been doing even then in that field. I think we need to continue to maintain our interest in that.

These are the people jamming unemployment offices and being left behind as our economy shifts its course. It is a matter of the highest national priority to help these people find a place in a society which demands new skills. It is also critical that we be aware of the potential for these new technologies to further divide society.

Those who cannot cope with our current society will be left even further behind unless we make up for our past inadequacies in education and training.

The other important skill required of a literate person in a technological society is the ability to process, organize and use information. As we enter the so-called information age, we are in danger of being drowned in a sea of paper and computer printouts. We in the Congress could be used as a case study of that problem.

It is an especially acute problem in a democratic system such as ours. Citizens must know where to go to get information, how to select from all the information available, and how to use that information to make democratic decisions. Many of the decisions they will be asked to make will require an understanding of science and technology.

I think we need to look at today's problem in the more comprehensive framework of a total technological literacy for the public of this country. If we adopt this overall approach, rather than thinking about just mathematics and science education, I think several more points become obvious. Clearly, we need to tackle the problem at a number of different levels, from elementary school education through adult education and retraining and through the universities. It is also clear that innovative curriculums and new educational structures may be needed. Although directing most of our energy toward science and mathematics education does serve as a stopgap measure for the immediate emergency, it will not be a complete long-term solution. As part of our response to the emerging national consensus on mathematics and science education needs, which was reflected in the President's state of the Union message, we can use this opportunity to begin a larger debate on education and the future of our country.

The magnitude and urgency of the problem is something that we can probably all agree on. The primary issue for Congress to discuss is determining the proper Federal role. I think the Federal Government, as I have indicated before, has an important leadership role to play in this field. It involves more than just distributing money to local school districts and colleges, although providing these supplementary funds is critically important today. The Federal Government should support educational research and curriculum development to improve the teaching in this field. The Federal Government can support and reward models of excellence, whether they be outstanding teachers, outstanding curricular programs, or outstanding schools. The lessons learned from these models of excellence will benefit each student, teacher, and school in the country. The National Science Foundation has in the past supported these types of programs, and I think NSF can continue to have a role in this part of the need that we face.

The most crucial part of the Federal role is to bring together and encourage linkages between all the segments of our society that should be concerned about the science education problem. A partnership approach, involving industries, universities, local schools, and parents is the only effective long-term solution. Cooperation and resource sharing between these various groups can help to solve some of the problems caused by such things as obsolete instrumentation and by the pay differential between the schools and industry, whether at the secondary level or in engineering colleges.

Finally, the Federal Government should insure that programs begun now in response to a surge in public interest will be maintained over time, and I should also add that they should be disseminated widely throughout our society. I hope that we can do a better job in sustaining the effort than we did in the years following the Sputnik uproar of 20 years ago.

In 1959, the Committee on Science and Astronautics, as it was called then, held hearings very similar to those we are holding today. The Committee on Education and Labor, of course, was also holding many hearings at that time while working on the National Defense Education Act. In looking back through those Science Committee hearings, I came across a quotation which I think has even more relevance today than it did in 1959 when it was quoted, and more than it did in 1916 when it was first said by Alfred North Whitehead—and I quote the statement he made then:

> In the conditions of modern life, the rule is absolute: The race which does not value trained intelligence is doomed. Not all your heroism, not all your social charm, not all your wit, not all your victories on land or at sea, can move back the finger of fate. Today we maintain ourselves. Tomorrow science will have moved forward yet one more step, and there will be no appeal from the judgment which will then be pronounced on the uneducated.

One additional thing, Mr. Chairman. I was looking back over some of the hearings in the Science and Technology Committee, and I would like to include in the record at this point a couple of pages devoted to the exploration of this problem in the committee report, in the 97th Congress 2 years ago. It has an excellent discussion of this field and the need for creating some of these linkages that I have described. I would like to submit that portion for the record.

Mr. Chairman, I look forward to working with you cooperatively in meeting this challenge and helping to create a sense of urgency about meeting this problem within the entire Congress.

Thank you very much.

[Prepared statement of Hon. George Brown follows:]

Prepared Statement of Hon. George E. Brown, Jr., a Representative in Congress From the State of California

Mr. Chairman, I want to thank you and Chairman Perkins for allowing me to testify before your subcommittee on this very important subject of mathematics and science education. I congratulate Chairman Perkins for his efforts over the years on behalf of science education through the National Defense Education Act. I have good memories of serving under the able chairmanship of Mr. Perkins in the 88th Congress when we were both Members of the General Education Subcommittee of the Committee on Education and Labor. Today, I am serving on the Committee on Science and Technology. We on the Science Committee share your concern about the state of math and science education in our county. I am confident, and I know you share this confidence, that our committees will be able to work together and formulate an appropriate federal response to the crisis we are now facing.

Whenever Congress is faced with a subject that doesn't fit neatly into just one committee's jurisdiction, we are required to look at the issue from more than one perspective. Although the legislative process seems to be a barrier at these times, it can force us to synthesize creative solutions instead of applying old solutions to new problems and changed conditions. For this reason, I am looking forward to working with the Members of this Committee and with the Administration during the 98th Congress.

When we talk about the crisis in mathematics and science education, I think the underlying concern is that we have not been properly training and educating the American public and workforce for life in a technological economy and society. As President Reagan pointed out in his State of the Union address, the education and training needs of our society are changing as we move to an economy based more heavily on services and information. While improved mathematics and science education is an important first step to meeting these new educational needs, the real need is for improving our "technological literacy."

"Technological literacy" refers to the foundation of skills required for living and working productively and humanely in a technological age. One of the important skills required to be technologically literate is the ability to use and control new technologies, such as computers and word processors. This requirement applies not only to those who are students today, but also to adults, including Members of Congress.

Our children are our future, but adults will provide the transition to the technological society. Even more important than the ability to use or program one of today's computers is the ability to continue learning and adapting throughout one's life. As the rate at which new technologies are introduced continues to accelerate, the high technologies of today will be replaced by even higher technologies of tomorrow. Therefore, we need to concentrate on creating a foundation of skills upon which more specific training needs can be built.

The education and training needs of our adult population are critical. These are the people jamming unemployment offices and being left behind as our economy shifts its course. It is a matter of the highest national priority to help these people find a place in a society which demands new skills. It is also critical that we be aware of the potential for these new technologies to further divide society. Those who cannot cope with our current society will be left even farther behind unless we make up for our past inadequacies in education and training.

The other important skill required of a literate person in a technological society is the ability to process, organize and use information. As our society moves into the so-called Information Age, we are in danger of becoming drowned in a sea of paper and computer print-outs. Congress, as you are all aware, could be used as a case study of this problem. It is an especially acute problem in a democratic system such as ours. Citizens must know where to go for information, how to select from all the information available, and how to use that information to make decisions. Many of the decisions they will be asked to make will require an understanding of science and technology.

I think we need to look at today's problem in the more comprehensive framework of technological literacy, or education for a technological society. If we adopt this overall approach, rather than thinking about just mathematics and science education, I think several points become more obvious. Clearly, we need to tackle the problem at a number of different levels, from elementary school education through adult education and retraining. It is also clear that innovative curricula and new educational structures may be needed. Although directing most of our energy toward science and mathematics education does serve as a stop-gap measure for the immediate emergency, it will not be a long-term solution. As part of our response to the emerging national consensus on mathematics and science education needs, we can use this opportunity to begin a larger debate on education and the future of our country.

The magnitude and urgency of the problem is something that we can probably all agree on. The primary issue for Congress to discuss is determining the proper federal role. I think the federal government has an important leadership role to play in science education. It involves more than just distributing money to local school districts and colleges, although providing supplementary funds is very important. The federal government should support educational research and curriculum development to improve the teaching of science, mathematics and technology. The federal government can support and reward models of excellence, whether they be outstanding teachers, outstanding curricular programs, or outstanding schools. The lessons learned from these models of excellence will benefit each student, teacher and school in the country. The National Science Foundation (NSF) has, in the past, supported these types of programs, and I think NSF can continue to serve an important role in the future.

The most crucial part of the federal role is to bring together and encourage linkages between all the segments of our society that should be concerned about the science education problem. A partnership approach, involving industries, universities, local schools, and parents is the only effective long-term solution. Cooperation and resource-sharing between these various groups can help to solve some of the problems caused by obsolete instrumentation and by the pay differential between academia and industry, whether at the secondary school level or in engineering colleges.

Finally, the federal government should ensure that programs begun now in response to a surge in public interest will be maintained over time. I hope that we can do a better job in sustaining the effort than we did in the years following the Sputnik uproar.

In 1959, the Committee on Science and Astronautics (as it was called then) held hearings very similar to those we are holding today. The Committee on Education and Labor, of course, was also holding many hearings at that time while working on the National Defense Education Act. In looking back through those Science Committee hearings, I came across a quotation which I think has even more relevance today than it did in 1959 when it was quoted and more than it did in 1916 when it was said by Alfred North Whitehead. Whitehead said:

"In the conditions of modern life, the rule is absolute: The race which does not value trained intelligence is doomed. Not all your heroism, not all your social charm, not all your wit, not all your victories on land or at sea, can move back the finger of fate. Today we maintain ourselves. Tomorrow science will have moved forward yet one more step, and there will be no appeal from the judgment which will then be pronounced on the uneducated."

Mr. Chairman, I look forward to working together in meeting this challenge. I thank you again for the opportunity to testify this morning.

[97th Congress, 1st Session, Report No. 97-34]

AUTHORIZING APPROPRIATIONS TO THE NATIONAL SCIENCE FOUNDATION

II. VIEWS ON PROGRAMS AND POLICIES

1. Science and engineering education

The committee is strongly concerned with the present state of science and engineering training at all levels within the nation's educational system. The need for engineers and experts in certain other scientific disciplines has reached crisis proportions on a national scale. Maintaining technical skills and science understanding in the nonspecialist public is also crucial to our nation's competitiveness and good judgment in a technical industrial world. It is the committee's view that the Science Foundation plays an instrumental role in establishing priorities and providing key catalytic programs to address the problems in this area. The Foundation is both authorized and required by its enabling statute to strengthen scientific and engineering education at all levels. Any change in that basic policy should be accompanied by appropriate Congressional action and deliberation and not through bureaucratic expediency. The Committee strongly feels that the reasons for the Foundation's charter in science and engineering education remain valid and that adequate funding for science and engineering education must continue.

While recognizing the need for budgetary stringency in Federal spending, the committee feels that the elimination of the Science and Engineering Education Directorate as proposed by the Administration is unwise and unwarranted. It is the committee' view that the Directorate should be entirely reorganized to address areas of highers priority and to provide for effective flexibility in allocating funds made available in this legislation. Though such funding is at a much reduced level from current spending levels, it is expected that reorganization and consolidation of certain programs will allow for the priority problem areas to be addressed at approximately the same level. It is not the Committee's intent that such reduction indicate lack of support for the Foundation's science and engineering education programs. Rather, it is intended that the reorganization and funding flexibility open the way for renewed emphasis and creativity in allocating resources to this area critical to national welfare and security. In forming its own view of the future of this Directorate, the Committee will rely heavily on the judgment of the foundation management as well as National Science Board recommendations derived from an orderly analysis of organizational alternatives and opportunities.

Discussion

A combination of circumstances has brought the national level of engineering and certain areas of science education to a crisis state that will continue to worsen unless strong and immediate measures are taken. The following statistics noted at the hearings outline some of the parameters of the problems:

1. Only one-sixth of secondary school students take science or math beyond the tenth grade.
2. Only one-third of the Nation's 17,000 school districts require more than one year of mathematics or sciences. Meanwhile, admission standards to colleges and universities have declined.
3. There are 40 percent more undergraduate students in engineering today than 10 years ago. There is correspondingly 10 percent fewer faculty.
4. Laboratory, instructional, and research equipment has degraded to the point of obsolescence, and competitiveness with the teaching standards in Japan, Western Europe, and even the Soviet Union has eroded.
5. It is estimated that $1-$2 billion is necessary to remedy only the instructional equipment problem.
6. Increasingly, salaries, particularly in such fields as computer sciences, have attracted qualified faculty away from the universities and into industry thus decreasing both the quality and the quantity of potential new faculty entering graduate schools.
7. The Soviets, as well as nations such as Japan, West Germany, and others, are accelerating all of their science and engineering programs. The Soviets are also turning out over 1 million technical specialists from secondary schools annually. The United States has no comparable program.

As noted in testimony, a high level of performance of the scientific and engineering professions is essential for our continued industrial vitality and for our national defense. The quality of life and the economic well-being of the country depend on many factors but they cannot be maintained, much less improved, without an ever increasing U.S. engineering and scientific competence.

A recent survey of all Federal programs, including the Department of Education and the National Institutes of Health shows only $37 million for any support of engineering education. Most of these programs address only special concerns, such as bio-medical engineering or marine engineering for the merchant marine officer cadets program. Only the Foundation supports broad, comprehensive engineering education programs. The same is true of basic science education where the Foundation's current effort approaches more than one-third of the estimates available. As well, the Foundation supports better than 60 percent of all Federal precollege science education programs.

Initially, during its early history, the Foundation was reluctant to take the lead national role in science and engineering education. Yet, these programs were found to be necessary in order to promote the high quality of science and engineering that is the basis of the Foundation's research responsibilities. In the past the Congress has added subelements to the programs which, while important in addressing specific concerns, complicated the flexible and efficient management of the overall goals of the directorate. Such subelements have also made it difficult to redirect resources as priorities and concerns have shifted. Thus, a reorganization would allow for greater flexibility in addressing areas of greatest concern while providing the most effective means of allocating funds made available for this program.

Consultation with various experts as well as testimony received on the problem indicates that reorganization should focus on the entire range of education to include: precollege science education; undergraduate education; graduate education and general science education, and technical literacy.

It is the view of the committee that such reorganization should include the following important elements:

Fellowships and traineeships at the graduate level,

Instructional equipment for undergraduate education, particularly in the fields of engineering and computer science,

Teacher training programs for faculty development of under graduate and secondary school faculty,

Student science programs at the pre-college level to attract greater consideration by young people of science and engineering as a career, particularly women and minorities,

Policy development and research aimed at information analysis and collection, as well as research and development oriented specifically to practical solutions of problems in education in the sciences and engineering, and

Programs designed to provide more effective communication of general science and engineering ideas to the public at large.

The committee believes that there are a number of effective ways in which the concerns outlined above could be adequately addressed. An example of one of the programs which the Committee feels has been particularly successful is the resource centers for science and engineeering. The centers are regional in nature and focus on a number of concerns across the spectrum of science and engineering education, including precollege, college and post-graduate activities. These centers have also proven to be highly effective in providing access to training and careers in science and engineering for minority and low income students. The committee supports the regional strategy used, which allows the effective coordination and mutual reinforcement of efforts in the community, schools and undergraduate institutions of a region. The Committee believes the Foundation should look to continued emphasis on programs such as the resource centers taking particular care in maintaining an equitable geographical distribution of such centers to take adequate advantage of potential talent throughout the nation.

It is expected that the Foundation will establish suitable priorities using the above concepts as guidelines. A final program reorganizational plan should be submitted to Congress no later than December 1981.

Chairman PERKINS. Let me compliment my colleague from California for his testimony here this morning. We worked together for several years before you left the House Committee on Education and Labor.

We need the National Science Foundation to continue, perhaps on a much greater scale, the high level research which they have done throughout the years; if appropriations permit, many more higher educational institutions can be funded than in the past. But we must not forget the overall situation existing throughout the United States. The disadvantaged must not be neglected in our efforts to develop better scientists and mathematicians and modern foreign languages.

It is my hope that all of us can get together, without any friction anywhere. The only problem that I see facing us is the shortage of funds, the inadequacy of the funding. That is the big problem, and it is our hope here on the committee to move this bill next week if we can possibly do it.

I certainly want to thank my colleague for coming here this morning. Mr. Simon.

Mr. SIMON. I thank you for your testimony and have just one question.

You speak about the need for a more comprehensive framework of technological literacy or education for a technological society, and you say we need an overall approach rather than thinking about just mathematics and science education.

We're going to probably be marking up this bill within a couple of weeks. As you look at this bill, are we moving in that direction, or are we—if George Brown were just to sit down and write an ideal bill, how would that compare with the product that we have before us?

Mr. BROWN. Mr. Simon, I'm a supporter of this bill. I think this bill is very badly needed.

I don't know that I could offer any suggestions. I think that if it is broadened to include the foreign language emphasis that you indicate, it would be a further improvement. But as Chairman Perkins indicates, the problem is taking realistic amounts of money that will be available and spreading them in such a way as to get the maximum effect.

The thing that bothers me a little bit is that I don't think this bill, by itself, meets the whole problem, because it doesn't go far enough in bringing about those linkages that I referred to, where we have to get these great elite institutions involved in the processes of education. They do not turn out the teachers, for example, that teach in the elementary schools. They may turn out the administrators who head up the teachers' colleges, but they don't turn out the teachers. We have to put some emphasis on improving the teachers' colleges, the teachers themselves in high school and elementary schools, and we have to see this as a web in which every part has to be given consideration and work together.

Mr. **Simon**. Thank you very much.

Chairman **Perkins**. Mr. Gunderson.

Mr. **Gunderson**. Thank you, Mr. Chairman. It is always a privilege to work with Mr. Brown. I had the privilege of working with him not only on the Ag Committee but with his particular subcommittee as well.

In reading over your statement, I have one particular question. You make the statement, "The most crucial part of the Federal role is to bring together and encourage linkages between all the segments of our society that should be concerned about science education problems."

I agree. My question is, how do we legislate that?

Mr. **Brown**. Mr. Gunderson, I don't think we're going to be able to do that by legislation. But let me say in an optimistic note that I think we're ahead of many other countries, maybe most other countries, in bringing about that condition because we are a democracy in which all the people are involved, and we have a multitude, a pluralism, of approaches to meeting a problem like this.

For example, today there has been an explosion of material aimed at creating a better understanding of science in the mass of the public in this country, done without Government programs I might say. Time magazine is devoting more efforts toward it. Science magazine is devoting more efforts to it. National Geographic is devoting more attention to public education and creating an awareness of the significance of science.

What we have to do is to provide guidance as to the overall significance of this and its importance to the national welfare. And in critical areas, where needs are not being met—and I think this bill addresses those critical needs—we have to give special attention. But we do not by ourselves have the total answer to it.

Mr. **Gunderson**. I note in going over your statement that you really do not make a great deal of comment about teachers. You get at the supplementary funds; you get at the curriculum, et cetera.

In your studies, how do you think we best can handle the problem of maintaining quality teachers in the profession?

Mr. **Brown**. Well, I deliberately didn't approach that question, proposing to focus instead on one or two other saliant points. But I don't think I have an answer to that. I just finished yesterday talking to the president of a major teacher training college in my region about what they are proposing to do there. They are proposing a new emphasis on science, math, technological literacy, and they are proposing to do that by supporting an upgrading of the science curriculum in the schools. They are proposing new and more imaginative and innovative programs in the college to attract better people into the science teaching arena. They are thinking in terms of how to secure additional incentives for these teachers when they move into the school system, where there are no additional incentives at this point. But where incentives might be arranged, for example, by better linkages, the point that I have been making, between the schools and local industry, where opportunities for summer jobs could be provided for science teachers in the high schools that would allow them to move back and forth, both the industry and the schools could benefit from that.

But I think this committee is the proper place to give the detailed consideration to that question and to come up with innovative solutions. And while I doubt if we will completely solve the problem, we will be making progress on it.

Mr. **Gunderson**. Thank you, Mr. Chairman.

Chairman **Perkins**. Mr. Miller.

Mr. **Miller**. Thank you, Mr. Chairman. I want to thank you, Mr. Brown, for your testimony.

I am delighted to see that on page 4 you propose some consideration of the National Science Foundation moving to the forefront in an attempt to reward models of excellence, whether they are individual teaching efforts or curricula or outstanding schools. I have been in Congress 8 years and in 8 years I have seen the politicians take shots at the National Science Foundation. If it hasn't, it has come very close to completely crippling that organization, and we may be paying some of the price for that. To the extent that we have discouraged research in certain areas because we haven't liked the way the scientists have labeled that research, so we have taken the political response.

But I would hope we would give consideration in both your legislation and the legislation before this committee on looking for ways that the Federal Government can, either through the prestige of the National Science Foundation, or other organizations, to work with local business and industry to reward people who are doing an excellent job, to reward people who are interested in advancing in terms of their teaching abilities, so that we can in the most immediate fashion possible get these people the additional necessary experience or training because the children are already in the schools. We are not holding up this population waiting to get this supertrained group of teachers. They are in school and progressing on a year-by-year basis. I would hope that we would fashion in this legislation on some kind of matching basis contributions by local government, public entities, the Federal Government, and perhaps industry, so that we could make a summer experience for an interested and well-trained teacher, meaningful, that they could bring back to that classroom, back their enthusiasm, and let it rub off on another 100 or 150 students during that year, and we could start building on the successes and give teachers who are willing to put in the additional work and time the knowledge that they very possibly can be rewarded for that effort, because I don't think that exists in our school systems today because of all the financial problems that we're all so aware of.

I would hope that the National Science Foundation, that we could work out a way that they could move to the forefront in that effort.

Mr. **Brown**. I think that might be a reasonable allocation of roles. The trouble with a focus exclusively upon excellence is that it sometimes leads, in the normal human way, to the creation of what you might call elitism, which requires that we give the focus that Chairman Perkins has to making sure that we don't let the neediest be sacrified because we are trying to encourage the very highest quality. We need to do both. In fact, it is the accomplishments of the geniuses of our society, those who are most qualified, that frequently inspires and stimulates those in, say, the elementary schools to a career in the field of that genius.

I have an interesting example of this. In California—and you may be well aware of this—the university system is looking for an outstanding global-class science project that they can support themselves without Federal aid. The thing that they have set on is to build the world's finest ground-based telescope, a 10-meter telescope, twice as large as any that exists in the world today, and to capitalize on that and the high quality of astronomers already there to inspire in California a new interest in the significance of that grandest of the sciences, astronomy, which explores the outermost reaches of the universe.

Now, that could do a great deal to stimulate an interest amongst the children of California in a career in science or technology, while at the same time promoting the finest science research that exists anywhere in the world.

Mr. **Miller**. Lest my remarks not be misinterpreted, when I talk about rewarding excellence, I would hope that we would have the ability to recognize excellence in fourth and fifth grade math teachers and in reading teachers who are building the foundation, so that the children will be able to read, so they can exercise their options to go into astronomy or physics or advanced mathematics, whatever it is, and that we will understand that they are a very, very important part of that component, not simply rewarding the elite researchers of our society, but recognizing the role that these individuals play hopefully so that they will then recognize in a manner of self-esteem and importance the role that they play in the so-called new technical society, that they, in effect, provide the launching pad for these young people.

But it is a matter of providing the esteem and the standing in the community, and I think that comes through recognition of the daily task that they have in that classroom. I would just encourage that kind of joint effort that I know is being tried in California with industry and local school districts.

Chairman **Perkins**. Mr. Craig.

Mr. **Craig**. Thank you very much, Mr. Chairman.

Mr. Brown, I appreciated your testimony. I guess one question that concerns me, as we head in this direction toward assisting in the area of math and science and hopefully furthering that cause, is the construction of this particular piece of legislation following along the old NDEA funding formula base. My concern—and I think it lends itself to some of your statements—is the act can be, I think, characterized as relatively untargeted.

Do you see the need to target, if we are to bring about some degree of specialization? In a limited funding situation, where do we target first, let's say in the first 2 to 3 years? Are we going to go after educators specifically in training programs, or are we going to broaden the base and dilute the general effect of the funding that may come in this?

Mr. BROWN. Well, I'm not sure I have a very good answer to that. The total amount of money involved in this bill is really not very large compared to the education budget of this country. In effect, to pass a bill of this sort focusing just on science and math education is almost symbolic more than anything else. It indicates a congressional concern, and as the President indicated, a Presidential concern, in his state of the Union message, for improvement here. What we have to hope for is that at the local school board level and at the State level this will encourage some of the targeting needed to meet the particular needs of that State or that school district.

In one situation it may be that they need targeting on, we will say, educational equipment, laboratory equipment or something of that sort. In another it may be a shortage of adequately trained teachers. They may be using uncertified math or science teachers. I think it is up to the local school board and to the State to determine what the targets are in that State, even perhaps what area of science it must focus on that meets the needs of the people of that State. So you run into that problem in trying to define a specific focus at the national level, and I think I would prefer to leave it in a little more general form with the discretion to focus at the local level.

Mr. CRAIG. Mr. Brown, don't we run the risk, though, of sprinkling some money across the education system of this country ? I would have to agree it relates to the total scope of education in this country and what we may be after, but this is a smaller amount than some would like to see. Don't we run the risk of just sprinkling money and accomplishing very little and, a couple of years down the road after upwards of a billion or better is spent, saying "Now where are we" and "We've got a piece of equipment here that is better and a piece of equipment there that's better, and an educator here or there;" but in the general thrust we have not effectively lifted the level or the quality of science and math education as we were hoping to do?

Mr. BROWN. Yes, you do run into that problem. In looking specifically at the bill, which allocates $50 million to five different programs for postsecondary education, you take $50 million and divide it up amongst five programs, and spread it out over the entire country, you have nothing but driblets. There is really nothing to sustain there, even though each of the five programs, in itself, is a valuable program.

I'm concerned about that, but I don't know how, in these times of stringent economies, we're going to be able to resolve it. If we go this route, we have to look at these splintered programs as prototypes. We have to choose and make each of them a demonstration and hope that it will spread with local support, or State support. Otherwise, you're quite correct, when this program funding ends, the programs will probably end.

Mr. CRAIG. Thank you very much.

Thank you, Mr. Chairman.

Chairman PERKINS. Mr. Kildee.

Mr. KILDEE. I want to thank Congressman Brown for his testimony and his leadership in this field. I have no questions at this time.

Chairman PERKINS. Mr. Petri.

Mr. PETRI. No questions.

Chairman PERKINS. Mr. Bartlett from Texas. Any questions, Mr. Barlett?

Mr. BARTLETT. No.

Chairman PERKINS. Let me ask you a question, Mr. Brown. I understand the administration is still up in the air as to whether to target the funds toward developing math and science teachers or to give the States block grants. Yesterday the White House was favoring the block grant approach, and then made a 180-degree turn from what I understand.

We have here $300 million for 1984, and the President is talking about $50 million. Over in the Senate, the leaders over there, even the Republican leaders, are up to $251 million. So we are in the ball park here with $300 million, which is very limited. If we had ample funds, we would not have this problem.

But I'm asking you if you are recommending that we expand the focus to include the technology education, but still leave the limited amount of funds the same that I referred to?

Mr. BROWN. I'm not sure I understand the final thrust of your question, Mr. Chairman. Is it is this an adequate amount to include technology education?

Chairman PERKINS. Yes, to add that on.

Mr. BROWN. Well, in my opinion, no. I don't think this is an adequate amount. You know as well as I do that 10 times this amount of money could be easily used to meet the educational needs of this country, in the overall or even in the science and engineering field. I perceive this as an indication of congressional priorities more than anything else, or national priorities, not as a solution to the education problem or the science education problem.

Chairman PERKINS. Let me thank you very much for your testimony. It has been most helpful.

Mr. BROWN. Thank you, Mr. Chairman.

Chairman PERKINS. Mr. Stokes, did you have a statement at this time, or are you with the panel?

Mr. SIMON. He has a witness that he wants to introduce.

Chairman PERKINS. All right. Let me call the panel around, and then I will let you introduce your witness.

Stanley O. Ikenberry, president of the University of Illinois; Morris Norfleet, president of Morehead State University; Nolen Ellison, chancellor of Cuyahoga Community College; and Rev. William J. Byron, S.J., president, Catholic University of America. That's the first panel.

Mr. Stokes, you go ahead first and introduce your gentleman, and then we will take them in order. We are delighted to welcome our colleague from Ohio.

Mr. STOKES. Thank you very much, Chairman Perkins, Chairman Simon, and members of the committee. It is always a pleasure, Mr. Chairman, to have the opportunity and privilege of appearing before you and this distinguished committee.

I have the privilege and high honor this morning of presenting to this committee a very distinguished educator from the city of

Cleveland, Ohio. Dr. Nolen Ellison, who appears on this panel to represent the 1,200 community colleges nationally and to testify on their behalf on this legislation before you, is a very distinguished educator who as chancellor of the Cuyahoga Community College located in Cleveland, Ohio, a three-campus institution now celebrating its 20th anniversary.

Mr. Chairman, you would be interested in knowing that Cuyahoga Community College has 28,000 credit students, $16 per credit hour tuition, and is open to all persons in Cuyahoga County. We are proud of the fact that it is now the third largest higher education institution in the State of Ohio.

Under Dr. Ellison's leadership, this institution has become relevant to the entire community; that is, he has brought this institution to the community and made the two a part of one another.

We are particularly proud of what Dr. Ellison will testify about this morning. Even though he represents all the community colleges throughout the Nation, Dr. Ellison will tell you about something we are very proud of in Cleveland—the Cuyahoga Community College Center for Science and Technology. Dr. Ellison's institution has brought about a linkage between NASA, the Cleveland public school system, and his institution, whereby our young people are now exposed through the Cleveland public school system to satellite communication technology, aerospace technology, and I understand that they are now planning a future course that would deal with energy utilization.

This is just a part of the innovative approach that Dr. Ellison has brought to this institution and to our city. I am just delighted to be here with him. He is a man who even before coming to Cleveland had distinguished himself greatly. As you know, Nolen Ellison is a former All-American in basketball, football, and baseball. But beyond that, at 31, he was the youngest college president in America—that was some years ago, of course, too. [Laughter.]

It is indeed a pleasure and honor for me to be here with this very distinguished educator.

Chairman PERKINS. Let me thank you very much, Mr. Stokes. We will defer the testimony. You don't have to remain, but we appreciate your generous introduction.

Mr. STOKES. Thank you.

Chairman PERKINS. At this time I want to call on Mr. Simon.

Mr. SIMON. Mr. Chairman, I was just about to tell Dr. Ellison how well represented he was and what a great diplomat and Congressman he has, until he got to the point where he said, "that was some years ago, of course," I knew that Lou Stokes was slipping. [Laughter.]

Chairman PERKINS. Go ahead, Mr. Simon. Do you want to introduce Dr. Ikenberry?

Mr. SIMON. I would be pleased to introduce Dr. Ikenberry. He has not been at the University of Illinois too long yet—how many years now?

Dr. IKENBERRY. About 4 years.

Mr. SIMON. Four years. But he has been providing solid, substantial leadership, and we are very proud of Dr. Ikenberry.

Chairman PERKINS. Go ahead, Doctor.

305

STATEMENT OF STANLEY O. IKENBERRY, PRESIDENT, UNIVERSITY OF ILLINOIS

Dr. **Ikenberry**. Thank you, Mr. Chairman, Representative Simon. I am pleased to be here today and honored to appear before this committee. I speak with the endorsement of the American Council on Education, which is the large umbrella group of postsecondary education institutions in this country, but also with the endorsement of the American Association of Universities, which is comprised of the major research universities, graduate and research universities, in this country, and the National Association of State Universities and Land Grant Colleges with which I am sure you are also familiar.

I will file a statement for the record, but with the permission of the chairman I will not read that——

Chairman **Perkins**. Without objection, all the prepared statements will be inserted in the record, every one of them.

Dr. **Ikenberry** [continuing]. But I will not take the time of the committee, with your concurrence, to read that statement.

I would also like to submit for the record, Mr. Chairman, a copy of a report which I found quite helpful on this topic, entitled "Today's Problems-Tomorrow's Crises." It's a report of the National Science Board Commission on Precollege Education in Mathematics, Science and Technology.

If I could just read a concluding paragraph from that report, it states that "Apparently, no consensus has been reached that the future prosperity and international position of the United States depend critically upon broader public attainment in mathematics, science, and technology. In addition, there is no consensus that high quality mathematics, science, and technology education is a matter of national concern, transcending State and local interests and responsibility."

I hope those conclusions, Mr. Chairman, are too harsh or premature, but I do think they reflect a growing national concern about the status of science and mathematics and instruction in technology in this country.

The question remains, is there a problem, and after having listened only to the brief testimony that has been presented before this committee this morning—and I know you have had prior days of testimony—I would join in support and associate myself with the testimony of those who have gone earlier, to testify to the existence of a very severe problem in our Nation's schools and colleges at all levels, in the area of mathematics, science and technology.

The other question is, does it make a difference, does it make a difference in the life of this Nation? I think the answer to that is also unequivocally yes, it makes a very substantial difference. Ultimately, it could make all the difference in terms of the health of our economy. It has a very direct bearing, as was stated earlier this morning, on our national security, and ultimately it has a very direct bearing on the quality of life in this country.

The recent assessment of the problem—and it is difficult to find statistics that will adequately convey the dimensions of the problem—but there was a recent national assessment of educational progress in this country that showed that for 17-year-olds in the

United States, that, for example, 38 percent were unable to read a thermometer, that 58 percent were unable to find the area of a square once one of its sides was given. Eighty-four percent—and I tried this problem out on my 14-year-old son—84 percent were unable to solve the problem "6 is what percentage of 120."

While such findings and others strongly suggest that our educational system may not be teaching the basic skills necessary to participate successfully in this society and the economy of the present and the future, there are other signs that we are not producing the essential scientific and technical specialists that we need in this country. There are many thousands of jobs even now in the technical areas that go begging, even while this country has unemployment at record high levels. The number of Ph. D.'s in engineering, for example, awarded in this country to U.S. nationals has declined by 54 percent since 1972. The number of baccalaureate degree engineers produced by the United States, for example, is substantially below that of Japan. Japan produces twice the number of engineers than the United States, with one-half the population of this country. Indeed, the United States lags behind in terms of the ratio and its population. We lag behind not just Japan, which I think would not come as a surprise, but it may come as a surprise to some that we lag behind also the United Kingdom, Russia, and West Germany.

There are many dimensions to the problems, but certainly the one that has been talked about before this Committee relates to teacher shortages. One-half of the teachers in science and mathematics are being graduated from the colleges and universities today as compared to one decade ago. At the University of Illinois specifically, Mr. Chairman, of the 8,146 baccalaureate degrees that we graduated last year, only 49 of those students were certified to teach in the area of science and mathematics.

Chairman **Perkins**. Out of 8,146, only 49——

Dr. **Ikenberry** [continuing]. Only 49 were certified to teach in the area of science and mathematics.

Chairman **Perkins**. That's practically nil.

Dr. **Ikenberry**. It's practically nil, particularly in a State the size of the State of Illinois.

In engineering faculties, there are an estimated 2,000 vacancies across the country. The practical implications of that, Mr. Chairman, in the case of the University of Illinois, we happen to have one of the largest, if not the largest, colleges of engineering in the country, and it was necessary for us to cut last year our admissions to that college by 10 percent simply because of the inability to find and pay for teachers and to provide equipment and laboratories to accommodate the number of students enrolled. We do have severe equipment problems, quite apart from the teachers, at the elementary and secondary and college and university levels, severe equipment problems.

Again, just using our university as a single example—and other universities across the country could cite their own statistics—in our instance we believe we should be investing $20 million annually in equipment replacement. We are now investing $5 million, so we are falling far short and getting farther behind each year.

Salaries are a very severe problem for teachers in science and mathematics, maybe the single greatest problem at the elementary and secondary level, in the ability to both attract and retain qualified teachers. Our curriculum needs attention in science and mathematics. Outdated content, inadequate offerings in our public schools, again an example from the University of Illinois, we have generally a very high quality student body; we are fortunate to have good students and high competition for admission. And yet, of the students admitted at the University of Illinois, one-half of those students could have taken certain of the course work in mathematics that they take at the University of Illinois. They very well could have taken that same course work at the elementary or secondary level prior to coming to the University of Illinois. Remedial instruction in mathematics in this country, for example, has increased by 72 percent over the last decade.

We have been slow in education to adopt innovative instructional technologies to teaching science and technology. For example, in our particular university, 20 years ago the university developed a programmed logic for automated teaching operations, or a system called PLATO. It was one of the first computer-assisted instructional systems in the country. It now has 20 systems in operation around the world, with 200 remote sites, with some 13 million teaching hours to date. But most of this teaching has been at the college and university level and in industrial and government settings, with very little teaching through the PLATO system being accomplished at the elementary and secondary level, primarily because we have not taken the time and expended the resources in our Nation to develop the courseware, the curriculum, that can be taught by a computer. But there is no technological reason why, nor is there any pedagogical reason, why we cannot effectively apply technology to assisting the instruction and the improvement of competencies in science, math, and technology in our Nation's schools and colleges.

The solution, it seems to me, Mr. Chairman, must begin with a national determination to address and resolve the problem. Many speakers have spoken here yet this morning about the importance of joint action, and it is true there is no single agency of State government or Federal Government that can alone address in a significant way this problem. There is no single level of education, not the University of Illinois, or Morehead State Teacher's College, or the public schools at the elementary and secondary level, no single level of education in this country that can alone solve the problem.

One of the very special aspects of H.R. 30 that I think is to be commended, it is the single piece of legislation that does link together our elementary and secondary schools and our universities and colleges in a concerted, joint attack on this problem. It is a joint attack. I just finished a few days with the Business Higher Education Forum, which is composed of 20 or 30 of the Nation's corporate leaders, and 20 or 30 representatives from the higher education community. A great portion of that session, two-thirds of our discussion during that 2-day period, was devoted precisely to the problem we are discussing this morning, the implications of this Nation's dwindling manpower position in the area of science and technology, the problems of inadequate preparation at all levels of education in this country.

The State of Illinois has recently formed a commission on science and technology, again bringing together leaders from education and industry and government to address this problem at the State level. At the University of Illinois we are attempting, through a reallocation and a readdressing of our own priorities, to make a major attack on the problems facing engineering education at our particular institution, to try to shore up our equipment budgets that I cited to you earlier, to try to improve and expand our ability to train teachers in science and mathematics, including the use of summer camps, involving teachers and supervisors and students, high school students, to bring together the resources of the university on that problem.

The goals, it seems to me, should include a broadening of the pool of students who are well prepared in the fields of mathematics and science. And I might pause just a moment to distinguish between mathematics and science. The reason I think mathematics is so terribly important is competency in mathematics is fundamentally important to further competency in almost any branch of science, so the two must go hand in hand. But to broaden the pool of students, prepared at the elementary, secondary, and higher education levels in science and mathematics, to improve our curriculum, to expand the number of teachers at all levels available in this area, to modernize our equipment, to apply technology to the teaching of science and mathematics and technology, and to increase the general societal literacy in this area and the quality of education in this country.

As we approach this, and in whatever piece of legislation that is finally endorsed by this committee and adopted by the Congress, I hope there will also be, as there is in this bill, a provision for research and development to assess the effectiveness of the efforts that are already being made to strengthen the quality of science and mathematics education in this country, and also to develop new approaches and more effective approaches to teaching in this area.

Mr. Chairman, I think you should know that you certainly have our support, the support of the education community, as you address what is a terribly significant problem for the life of our Nation, and certainly a very central problem in the life of American education.

I thank you for the opportunity to appear here.

[The statement of Dr. Ikenberry with attachment follows:]

PREPARED STATEMENT OF DR. STANLEY O. IKENBERRY, PRESIDENT, UNIVERSITY OF ILLINOIS

Mr. Chairman, and members of the Committee, I am Stanley O. Ikenberry, President of the University of Illinois. I am pleased to have the opportunity to appear before you today to discuss the state of science, mathematics, and technology in American education and to comment specifically on H.R. 30 as it relates to postsecondary education. The 98th Congress will face no issue which will have a greater or longer-term impact on the economic health of the United States than preserving the preeminence of American science and technology.

It is quite distressing that the importance of the issue has heretofore not been fully recognized. I quote from the National Science Board's Commission on Precollege Education in Mathematics, Science and Technology July 1982 report entitled "Today's Problems, Tomorrow's Crises":

"Apparently, no consensus has been reached that the future prosperity and international position of the United States depend critically upon broader public attainment in mathematics, science, and technology. In addition, there is no consensus that high quality mathematics, science, and technology education is a matter of national concern, transcending state and local interests and responsibility . . . The absence of a national consensus on the importance of mathematics, science, and technology education for all citizens may be the central cause of the critical problem facing our educational systems. A broad national effort is essential."

Fortunately, there are encouraging signs that recognition of the problem as a significant national issue is expanding rapidly outside the educational community to government, industry, and the public at large. This legislation with these prominent hearings so early in the Congressional session follows a flurry of activity late in the 97th Congress. Mathematics and science education were mentioned specifically in both President Reagan's State of the Union message and the Democrat's response. Business and industry have become alarmed with implications of the problem for productivity and expansion. The Business-Higher Education Forum, of which I am a member, devoted almost the entire agenda of its semiannual meeting this past weekend to industry's growing unmet needs for scientifically literate, technologically sophisticated personnel.

It is critical that we as a nation and you as key policymakers move quickly to agree on the dimensions of the problem and to develop consensus on the major components of a comprehensive strategy for its solution. I would like to describe the problem as seen by my colleagues in postsecondary education, to suggest some broad goals for national action, to review some ideas that are working already, and to comment on the specific provisions of H.R. 30 as they relate to colleges and universities.

THE PROBLEM

The growing scientific and mathematical illiteracy of our general population is perhaps best illustrated by some findings of a recent study. The National Assessment of Educational Progress showed that for 17-year-olds in the United States: 38 percent were unable to read a thermometer; 58 percent were unable to find the area of a square given one of its sides; 84 percent were unable to solve the problem: 6 is what percent of 120?

While such findings and others strongly suggest that our educational system is not teaching the basic skills necessary to participate successfully in the society and economy of the near future, there are other signs that we are not producing the essential scientific and technical specialists either.

Tens of thousands of technical positions go begging even as unemployment exceeds 10 percent nationally.

The number of Ph. D.'s in engineering awarded to U.S. nationals has declined by 54 percent since 1972.

Japan produces twice as many engineers as the United States with half the population; the Soviet Union produces four times as many per capita. In fact, the United States produces less engineers per capita than the United Kingdom, West Germany, Japan and the Soviets. Despite this alarming fact, the University of Illinois College of Engineering, among the largest and best in this country, was forced by budgetary constraints to reduce its entering enrollments in the past two years by more than 10 percent.

The reasons for these problems are far less complex than their solution. First, we are not putting enough good instructors in the classroom and keeping them there. I'm certain you heard yesterday about the extreme shortage of qualified math and science teachers in our elementary and secondary schools. I'm sorry to report to you that there is no relief in sight in the near term. Nationally, math and science teacher training enrollments in our colleges and universities are less than half what they were a decade ago. Of the 8,146 students who received baccalaureate degrees from the University of Illinois in 1982, only 49 chose to be certified to teach high school math or natural science.

Faculty shortages exist in our colleges and universities as well. In engineering alone we estimate more than 2,000 unfilled faculty vacancies nationally. Many of our best students leave for industry rather than enter advanced graduate study; those who stay to complete a Ph. D. are often lured away from teaching. This situation is easy to understand in the contest of current salary differentials. This past year the average engineering graduate in Illinois with a four-year Bachelor of Science degree began his or her career at $24,800. At the same time we were offering $30,000 to beginning Ph. D.'s on the College of Engineering faculty.

A second cause for our national problem is the sorry state of scientific equipment in our classrooms and laboratories. The need for more and better state-of-the art equipment at all levels of education has been well-documented. In times of continued fiscal distress, however, equipment needs are often sacrificed to keep faculty and students in the classroom. The University of Illinois has an accumulated equipment deficiency well in excess of $20 million but has an annual equipment budget of less than $5 million. The deficiency is now growing at an annual rate of nearly $10 million. Deficiencies in the sophisticated research equipment which are an important component of graduate training in the sciences and engineering are even greater than those in teaching equipment. A 1980 study by the American Association of Universities found that the median age of instrumentation in ten research universities was twice that in two leading industrial laboratories. Although the obsolescence of scientific equipment has been recognized as a critical national problem by the National Institutes of Health, the National Science Foundation, the Department of Defense, and others, budgetary constraints have severely hampered attempts to deal with it.

A third problem is that high school curricula often fail to equip their graduates with adequate mastery of basic skills in mathematics and science. It is of major concern to those of us in postsecondary education that high school curricula have proved to be inadequate preparation for many students who choose to pursue advanced scientific and technological study in college. Thus, basic education must be provided by colleges and universities. Freshman mathematics students at the University of Illinois tend to be quite bright and highly motivated; they rank on the average in the 89th percentile or better in their high school class and in their scores on standard national examinations. Yet nearly half of them take courses in college which could have been offered in high school. Nationally, according to the National Science Board Precollege Commission, "Remedial mathematics enrollments at four-year institutions of higher education increased 72 percent between 1975 and 1980, while total student enrollments increased by only seven percent. At public four-year colleges, 25 percent of the mathematics courses are remedial; and at community 42 percent are." The most damaging effect of the growing lack of adequate precollege preparation even among bright students is the diversion of scarce resources from advanced work to remediation.

Fourth, and finally, many students with a demonstrated interest in science are turned off by instructional approaches which lack innovation or imagination. There is little real application, for instance, of computers or other advanced technologies to the precollege classroom even though their potential for teaching and raising interest levels is enormous. The same students who profess a dislike for school science ironically can be frequent visitors to our most interesting science museums and spend hours with video games. We are losing them as future scientists and engineers before they even enter high school.

NATIONAL GOALS

We must move quickly to improve the mathematical, scientific and technological knowledge of all citizens and we must keep a healthy proportion of excellent students flowing into our doctoral programs. As stated by the National Science Board Commission, we need a national consensus which transcends interests and responsibilities at all levels. I urge the adoption of the Commission's goals as national objectives: To continue to develop and to broaden the pool of students who are well prepared and highly motivated for advanced careers in mathematics, science and engineering; to widen the range of high quality educational offerings in mathematics, science and technology at all grade levels, so that more students would be prepared for and thus have greater options to choose among technically-oriented careers and professions; and to increase the general mathematics, science and technology literacy of all citizens for life, work and full participation in the society of the future.

POSTSECONDARY EDUCATION RESPONSE

While mathematics and science education problems require a concerted response from the Federal government, this is not to suggest that Congress alone can solve the problem. All levels of government and all levels of education must cooperate among themselves. As stated by the American Council on Education, America's postsecondary institutions have a definite role to play: "Their resources should be directed to the most critical problems that beset the science education system so that adequate numbers of qualified mathematics and science school teachers will be trained; education for technology and science-related careers will be provided; the proper research environment, experience and tools to train the next generation of scientists, engineers, and researchers will be encouraged; and research to improve instruction and the educational uses of information technology will be supported."

It is important for the members of this committee to know that the postsecondary education community is not merely wringing its hands waiting for Congress to act, but rather has begun implementing strategies aimed at solving at least part of the problem. At the University of Illinois, we have long been noted as a preeminent developer of computer-assisted instruction hardware and software. The PLATO educational system now marketed nationwide by the Control Data Corporation, for example, is the product of University of Illinois researchers. These same researchers are now exploring other ways to apply technology to teach technology better. Other faculty are working with local schools on micro-computer applications.

We are continuing a successful program for gifted high school students interested in careers in engineering. We are establishing summer camps for the brightest high school students to expand their knowledge in mathematics and the natural sciences.

We are working with the State of Illinois on a multi-year, multi-million dollar plan to upgrade the University's science and engineering equipment. The plan is being given a sufficient priority to survive all but the most Draconian budget cutbacks.

We are establishing an extended engineering program to allow engineers and technicians to receive continuing education off campus, during working hours to upgrade the skills as technology advances rapidly. The program was requested by industry and will be partially supported by the employers of the students in the program. We could develop similar programs for math and science teachers.

We are actively considering raising the entrance requirements for the University of Illinois to three years mathematics and two years of science in high school. Although the new requirements would have to be phased in rather than be effective immediately, we can send a message as to the importance of these subjects.

All of these efforts and others can be intensified and broadened with a renewed commitment to invest in building our strengths as the world's leader in math, science, and technology.

COMMENTS ON H.R. 30

I wish to begin my specific remarks on H.R. 30 by commending Chairman Perkins and the other members of this committee for their strong support of math and science efforts in the 97th Congress and for the introduction of and early hearing on the "Emergency Mathematics and Science Education Act." I wholeheartedly agree that this is an emergency which requires immediate attention even as we plot longer-term strategies. My remarks are confined primarily to "Part B—Postsecondary Assistance" which applies most directly to my own university and its sister institutions.

We were especially pleased to see included in the bill Section 624, "Strengthening Educational Research and Development." Further research is absolutely essential to better define the reasons for the problem and provide feedback to Congress on the outcomes of some early efforts at solutions. This would permit targeting of Federal funds more precisely in the years ahead. You may wish to include in Section 624 the creation of a national center (or centers) for the study of math, science, and technology education problems at the elementary level in particular. H.R. 30 quite correctly recognizes that improvement is needed at the elementary school level. We at the University of Illinois are encouraged by the prospects of such a center because our own Center for the Study of Reading has been so successful in identifying problems in reading comprehension and is becoming quite influential in changing reading education methods throughout the country. I would also suggest that you amend paragraph a(2) of the section to include "the development of instructional technologies" in addition to "research on the use of instructional technologies." The National Institute of Education could become a valuable source of support for the development of new software teaching packages.

I also commend your support for incentives to get more students into math and science teacher training programs as represented by the Congressional Scholars program. As we know more about what is deterring young people from entering the profession and failing to hold others there, we will want to attack this problem on a broader front with a variety of strategies. For the present, I would suggest that the Scholars be identified earlier than three years into college. That is almost too late to influence students to choose a career in math or science teaching and, therefore, would more likely reward those who have already made the decision rather than add to the pool of teachers.

I am also pleased to see Section 623 supporting summer institutes and workshops for teachers. Our experience is that these can be effective means of upgrading teaching skills and expanding knowledge of subject areas. We have found that summer programs are most effective when they are closely linked with activity throughout the school year. Thus, I would suggest some programmatic linkages in H.R. 30 between Part A fund uses and the Summer Institutes.

Finally, I would suggest that some support be given in the bill to special programs for gifted precollege students in mathematics and sciences. Successful programs like North Carolina's special school and our planned summer programs are critical to the supply of our future scientists and engineers.

CONCLUSION

Some of the problems I have discussed here today are not addressed in H.R. 30, but they also are outside the jurisdiction of this committee and the Department of Education. I recognize that you as a committee are somewhat constrained in your capacity to respond. The problem is so pervasive that it will not be solved by a single agency or committee anymore than it can be solved by a single college or school or single level of education. Its successful solution requires cooperation on a broad front.

In Washington jargon, its solution is also largely in the out years. American science has become preminent in the world as the result of years of sustained investments which can be traced back to our principle of university accessible free schools; to a national investment in basic research and more recently, to the National Defense Education Act. There are no quick fix solutions to the gradual erosion of those efforts, only a long-term, comprehensive sustained effort.

We commend you for beginning that process through these hearings of yesterday and today.

Mr. Chairman, that concludes my remarks. I would be pleased to respond to questions.

TODAY'S PROBLEMS TOMORROW'S CRISES

A Report of the National Science Board Commission on Precollege Education in Mathematics, Science and Technology

National Science Board
National Science Foundation

About the National Science Board Commission on Precollege Education in Mathematics, Science and Technology

In response to the current decline in the quality and quantity of precollege mathematics and science education in the United States, the National Science Board (NSB) established the Commission on Precollege Education in Mathematics, Science and Technology. The NSB Commission is composed of 20 persons from a wide variety of fields and is co-chaired by William T. Coleman, Jr. and Cecily Cannan Selby.

The purpose of the NSB Commission is to define a national agenda for improving mathematics and science education in this country. It will develop an action plan that will include a definition of the appropriate roles and responsibilities of federal, state, and local governments, professional and scientific societies, and the private sector in addressing this problem of national dimension.

The Commission will be active over a period of 18 months and will issue interim reports on its findings. The Commission is charged to:

- Examine the existing evidence on the quality of precollege (all classes, K-12) education in mathematics and science;
- Identify where current practices and policies fail to ensure the entry, selection, education and utilization of the full range of potential talent in science, mathematics and engineering;
- Identify and analyze existing mathematics and science programs, teaching materials and teaching techniques whose success may justify imitation or adaptation;
- Develop an understanding of the roles that all systems—government and private organizations, professional groups and individuals—can play in improving mathematics and science education;
- Establish a set of principles, options and strategies which can be used to improve the quality of secondary school science and mathematics education.

About the National Science Foundation

The National Science Foundation (NSF) was established on May 10, 1950, as an independent agency of the Executive Branch of the Federal Government. Public Law 507 of the 81st Congress states that the "Foundation shall consist of a National Science Board (NSB) and a Director." The NSF Act assigns policy-making functions to the National Science Board and the administration of the Foundation to the Director. The policies of the Board on the support of science, development of scientific manpower and improvement of science education are generally implemented through the various programs of the Foundation.

NATIONAL SCIENCE BOARD
NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

NSB COMMISSION ON PRECOLLEGE
EDUCATION IN MATHEMATICS,
SCIENCE AND TECHNOLOGY

WILLIAM T. COLEMAN, JR., CO-CHAIR
CECILY CANNAN SELBY, CO-CHAIR
LEW ALLEN, JR.
VICTORIA BERGIN
GEORGE BURNET, JR.
WILLIAM H. COSBY, JR.
DANIEL J. EVANS
DONALD S. FREDRICKSON
PATRICIA ALBJERG GRAHAM
ROBERT E. LARSON
GERALD D. LAUBACH
KATHARINE P. LAYTON
RUTH B. LOVE
ARTURO MADRID, II
FREDERICK MOSTELLER
M. JOAN PARENT
ROBERT W. PARRY
BENJAMIN F. PAYTON
JOSEPH E. ROWE
HERBERT A. SIMON
RICHARD S. NICHOLSON, EXEC. DIR.

October 18, 1982

Dr. Lewis M. Branscomb
Chairman
National Science Board
National Science Foundation
Washington, D.C. 20550

Dear Dr. Branscomb:

We are most pleased to transmit to you the first formal report of our Commission, "Today's Problems, Tomorrow's Crises." This report represents the Commission's assessment of the condition of precollege education in mathematics, science and technology in this country.

The problems summarized in our report--if left unresolved--will escalate in the years ahead. Thus, all Americans need to recognize the broad importance of mathematics, science and technology in the education of our youth. We hope, accordingly, that our report will receive wide dissemination.

The seriousness of the current situation underscores the Commission's resolve to develop, during the remainder of its life, an agenda for action for all sectors of society.

Sincerely,

William T. Coleman, Jr.
William T. Coleman, Jr.

Cecily C. Selby
Cecily Cannan Selby

Today's Problems, Tomorrow's Crises

Introduction

Across the United States, there is escalating awareness that our educational systems are facing inordinate difficulties in trying to meet the needs of the Nation in our changing and increasingly technological society. We appear to be raising a generation of Americans, many of whom lack the understanding and the skills necessary to participate fully in the technological world in which they live and work. Improved preparation of all citizens in the fields of mathematics, science, and technology is essential to the development and maintenance of our Nation's economic strength, military security, commitment to the democratic ideal of an informed and participating citizenry, and leadership in mathematics, science and technology.

To meet these ends, our formal and informal education systems must have the commitment and the capacity to achieve three equally important goals:

- to continue to develop and to broaden the pool of students who are well prepared and highly motivated for advanced careers in mathematics, science and engineering;
- to widen the range of high-quality educational offerings in mathematics, science and technology at all grade levels, so that more students would be prepared for and thus have greater options to choose among technically oriented careers and professions; and
- to increase the general mathematics, science and technology literacy of all citizens for life, work and full participation in the society of the future.

The first goal needs little explanation, since maintenance of U.S. scientific and technological capacity requires superbly educated mathematicians, scientists, and engineers. As the total number of 18-year-olds in the population continues to decrease into the 1990's, the percentage of high school graduates entering preprofessional, college-level courses in science and engineering must increase to meet future manpower needs. In addition, to meet the country's needs for excellence, creativity, and innovation in its scientific work, we must develop and utilize the talents of all Americans, including women and minorities (now currently underrepresented in the science and engineering professions).

The critical value of the second goal has become widely recognized during the past few years. The current gap between opportunities for those with and without credentials in mathematics, science and technology will increase dramatically as the technological complexity of U.S. society increases. Industrial leaders have identified the current shortage of trained technicians as a serious barrier to increased productivity. Military commanders echo this concern about their manpower requirements for meeting national security needs. In such professions as law, journalism, and business management, there is also a growing demand for men and women with backgrounds in mathematics, science, and technology. The current and increasing shortage of citizens adequately prepared by their education to take on the tasks needed for the development of our economy, our culture, and our security is rightly called a crisis by leaders in academe, business, and government.

The third goal is rooted in Thomas Jefferson's familiar dictum that an educated citizenry is the only safe repository of democratic values. The life and work of Jefferson and others make clear that a broad understanding of the relationships between science and society was considered by early Americans as integral to the ideal of the Republic. To lead full lives and to participate with confidence in contemporary American society, citizens need an understanding and appreciation of mathematics, science and technology.

This report reviews the status of math, science and technology instruction in our educational systems and explores some of the key problems and challenges facing those systems. The central conclusion to be drawn is that, in the aggregate, the U.S. educational systems currently are not satisfactorily achieving the second and third goals, and they will need assistance, although perhaps to a somewhat lesser extent, to meet the first.

The Principal Concern: Declining Achievement and Participation at a Time of Increasing National Needs

Data from a number of sources have documented declining student achievement in mathematics and science, as indicated by declines in:

- science achievement scores of U.S. 17-year-olds as measured in three national assessments of science (1969, 1973, and 1977);
- mathematics scores of 17-year-olds as measured in two national assessments of mathematics (1973, 1978); the decline was especially severe in the areas of problem-solving and applications of mathematics;
- mathematical and verbal Scholastic Aptitude Test (SAT) scores of students over an 18-year period through 1980; and
- students prepared for post-secondary study. Remedial mathematics enrollments at four-year institutions of higher education increased 72 percent between 1975 and 1980, while total student enrollments increased by only seven percent. At public

four-year colleges, 25 percent of the mathematics courses are remedial; and at community colleges, 42 percent are.

The proportion and qualifications of high school seniors who will major in mathematics, science, and engineering have remained roughly constant over the past 15 years, although college engineering enrollments have increased steadily since the mid-1970's. Some students are also receiving more advanced experiences in secondary school science and mathematics as indicated by performance on advanced placement tests.

Nonetheless, adequate mathematics and science course opportunities are not available for *all* talented and motivated students. As many as one-third of U.S. secondary schools do not offer sufficient mathematics to qualify their graduates for admission to accredited engineering schools. Only one-third of the 21,000 U.S. high schools teach calculus, and fewer than one-third offer physics courses taught by qualified physics teachers.

The evidence on student participation and achievement indicates a wide and increasing divergence in the amount and quality of the mathematics, science and technology education acquired by those who plan to go on to college and study in those areas and by those who do not. Students in the latter category generally stop their study of mathematics and science at a relatively early age, perform considerably less well on achievement measures than the career-bound, and do not have opportunities to pursue appropriate courses in contemporary technology. Only nine percent of the students graduating from vocationally oriented secondary school programs in 1980 took three years of science, and only 18 percent took three or more years of mathematics. Hence, it is clear that while the first goal stated in the introduction presently is being fulfilled reasonably well, the second and third goals are not. In fact, the educational system may actually have carried out these latter goals better 20 years ago: the proportion of public high school students (grades 9 to 12) enrolled in science courses has declined since that time. Thus, the principal concern with student participation and achievement is with those who do not plan careers in mathematics, science, or engineering.

In addition, wide differences persist in achievement and participation levels among students from different social groups. Women have traditionally participated less than men in science, and members of various minority groups (specifically, if not exclusively, American Indians, Black Americans, Mexican Americans and Puerto Ricans) have participated less and performed less well on standard science and mathematics achievement tests than their white counterparts. Approximately 20 percentage points separated the mathematics achievement scores of 17-year-old black and white students on national assessment tests in both 1973 and 1978. Approximately 15 percentage points separated 17-year-old Hispanics and whites in both years. Between 1973 and 1978, nine-year-old black students showed a definite improvement in performance on mathematics achievement tests, while the average performance of nine-year-old white students declined and that of Hispanics remained constant.

Specific Contributory Problems

Studies and analyses of conditions in the U.S. educational system—including both its formal and its informal components—point to four problems that contribute to declining student participation and achievement levels.

Teachers

Individual teachers have considerable discretion in the selection of course content and instructional approaches and, therefore, play a pivotal role in the education of students. Superior teachers of mathematics, science and technology can motivate students to do well in their courses and can stimulate students to take more advanced courses and consider technically or scientifically oriented careers. Mediocre and poor teachers may dampen the enthusiam of good students and fail to recognize and stimulate the development of potential talents in others. Therefore, the documented shortage of superior teachers must be considered a prime contributing cause of decreasing student participation and achievement in mathematics, science and technology.

There is also a growing shortage of qualified secondary school mathematics and physical science teachers. In 1981, 43 states (of 45 responding) reported a shortage of mathematics teachers. For physics teachers, 42 states reported such shortages. In the same year, 50 percent of the teachers newly employed nationwide to teach secondary science and mathematics were actually uncertified to teach those subjects. From 1971 to 1980, student teachers in science and mathematics decresed in number—threefold in science and fourfold in mathematics—and only half of them have actually entered the teaching profession. In addition, 25 percent of those currently teaching have stated that they expect to leave the profession in the near future.

Some of the problems that affect the participation and achievement of students at all grade levels are:

- Among certified teachers of high school mathematics and science, very few have had the formal educational preparation required to provide students with an understanding of modern technology.
- There are few available opportunities for certified mathematics and science teachers to update or broaden their skills and backgrounds. Such training opportunities are essential due to the rapid advances taking place in mathematics, science and

technology and the need to introduce new types of upper level courses for nonspecialists.

- There are few inservice programs to certify teachers who are presently not qualified to teach mathematics and science.
- Most teachers in the primary and middle school grades have not had training in science and mathematics or courses in methods to teach these subjects.
- District-level supervision has been reduced as a result of financial retrenchment or has been shifted from instructional to administrative support. As a result, relatively few people are available outside the classroom to provide quality control or to assist teachers with pedagogical problems.

Classrooms

Deficiencies in the numbers and qualifications of mathematics and science teachers are exacerbated by classroom conditions, including inadequate instructional time, equipment, and facilities.

The time available for adequate instruction in U.S. schools is far more limited than in other advanced countries. In the United States, the typical school year consists of 180 days, as contrasted with 240 days in Japan. This is further reduced by absenteeism, which amounts to an average of 20 days per school year. The typical school day is five hours long, compared with six- or eight-hour days in other countries. In addition, many periods of varying length throughout school days and weeks are devoted to nonacademic pursuits, both reducing the hours available for instruction and diverting the time and energy of teachers to noninstructional duties. Problems associated with student discipline and motivation, which are severe in some schools and affect the general learning environment, have been well publicized.

Many science courses in schools throughout the country are being taught without an adequate laboratory component or with no laboratory at all. In some cases, laboratory apparatus is obsolete, badly in need of maintenance, or nonexistent. In other cases, such apparatus is not used because of a lack of paraprofessionals or aids to set up and maintain equipment, a condition that has become increasingly important due to the greater concern for safety in the schools.

Curricula

Curricula in mathematics and in several scientific disciplines were developed with federal support two or more decades ago to provide rigorous, modern course work for high school students interested in careers in mathematics, science and engineering. These curricula, and several generations of privately-developed successors, continue to serve their purpose, though many need to be revised.

Mechanisms must be developed to incorporate effectively into the curricula changes associated with advances in the disciplines and evolving contemporary technologies.

Another curricular concern is that upper level high school courses based on these curricula are too abstract and theoretical for most students. In fact, serious doubts exist about whether many of the commonly offered mathematics, science and technology courses in the secondary schools are, in their present form, of much value to students planning careers outside of mathematics, science or engineering. Few courses or widely accepted curricula are available with the explicit aim of providing such students with adequate preparation in mathematics and science. In addition, courses associated with modern technology are not available; most courses, in fact, make little reference to technology at all.

In the lower grades, mathematics courses emphasize basic computational skills rather than interpretation and application. Science courses at those levels often are empty of content and, generally, do not build upon the work of previous grades.

Appropriate courses in modern technology are not available. Few systematic attempts are made to integrate learning in mathematics, science and technology. As a result, little coherent preparation is offered for the disciplinary courses (usually earth science and biology) encountered for the first time in the ninth and tenth grades. This condition is particularly unfortunate, because a wealth of information supports the conclusion that students who dislike mathematics and science courses in the early grades, or who receive inadequate instruction in those grades, are unlikely to participate effectively in upper level courses.

Instructional Approaches

In general, precollege mathematics, science and technology instruction has yet to take advantage of the advances in technology and behavioral science of the past 20 years. For example, computers provide an immense opportunity to develop curricula and instructional approaches that might motivate larger numbers of students and increase the flexibility of the programs available to them. Computers and other modern technologies are available in many U.S. schools, and imaginative uses are made of these instructional aids in individual classrooms. However, computer software is generally inadequate, and the full potential of these technologies for instruction has received little attention.

Considerable progress also is being made in research in math and science education. The cognitive sciences are providing a wealth of informatin on the way people learn. For example, knowledge is now available about the relative degree of abstraction that students of a particular age can be expected to grasp. However, such information has yet to be systematically applied either in the development of mathematics, science, and technology curricula, or in the training of teachers of these subjects.

Finally, there is evidence that many students who have an interest in mathematics, science, and technology are not being reached through instructional approaches currently used in the classroom. Whereas many students do not like school science—and form this opinion by the end of third grade—many do like the science and technology that they see on television. They also like what they encounter at science and technology museums, planetariums, nature centers, and national parks. Many of these institutions facilitate science and technology education with their own after-school, weekend, and vacation classes. In addition, many school classes make field trips to such institutions. Because these programs are apparently more appealing than school science offerings, the innovative instructional approaches used in them should be examined and, where possible, applied to the classroom setting.

Public Perceptions and Priorities

Largely, public schools reflect, rather than determine, public perceptions and priorities. The condition of mathematics, science and technology education reveals an apparent misperception by the public that adequate course work need only be provided to students preparing for college-level study in these fields and that these courses are unnecessary for other students. This is consistent with the broader perception that excellence in science and technology is vitally important to the Nation but that it can and should be left to the experts. Thus, its pursuit has little to do with the day-to-day concerns of most people—except when major news events such as a nuclear reactor accident or a space shuttle launch intrude. This misperception about the mathematics, science and technology training needed by students in our schools is tragic for our society as a whole.

Yet, a reasonable fraction of the adult public is interested in science and technology. This is evident from the recent popularity of science magazines for nonspecialists, quality television and radio programs (particularly in the public media), and science and technology museums. Although a large fraction of the public enjoys science and technology, it appears that many consider school mathematics, science, and technology as isolated from the real world and not essential for most students.

That misperception is part of a public view that the aims, substance, and quality of public education do not reflect the considerable economic, social, and cultural changes that have occurred in this country since the late 1960's. Today, an increasing percentage of the work force is concerned with the retrieval, processing, and transmission of information. Yet, public school mathematics and science courses are, at best, only peripherally concerned and preparing students to work and live in a society that concentrates on such tasks.

Apparently, no consensus has been reached that the future prosperity and international position of the United States depend critically upon broader public attainment in mathematics, science, and technology. In addition, there is no consensus that high quality mathematics, science, and technology education is a matter of national concern, transcending state and local interests and responsibility. Mathematics and science requirements both for high school graduation and for college entry have generally declined over the past 15 years. Although there are some encouraging signs that this trend is reversing, only about one-third of the Nation's 16,000 school districts require more than one year of high school mathematics and one year of science for graduation.

National Science Board Commission

The absence of a national consensus on the importance of mathematics, science, and technology education for all citizens may be the central cause of the critical problem facing our educational systems. A broad national effort is essential. The National Science Board Commission on Precollege Education in Mathematics, Science and Technology has been established to address this condition. The Commission will define, over the next year, a national agenda that should provide an action plan for all sectors of society to use in the achievement of the three important educational goals outlined in the introduction to this report.

Sources

The data appearing in this report have been drawn from the sources that follow. Specific citations and additional references may be obtained on request from the office of the National Science Board Commission on Precollege Education in Mathematics, Science and Technology.

1. National Science Foundation and Department of Education. *Science and Engineering Education for the 1980's and Beyond.* Washington, D.C.: U.S. Government Printing Office, October 1980, primarily Chapter V.
2. National Science Foundation. *Science and Engineering Education: Data and Information 1982. A Report to the National Science Board Commission on Precollege Education in Mathematics, Science and Technology* (NSF 82-30).
3. Papers presented at the National Academy of Sciences' Convocation on Precollege Education in Mathematics and Science, particularly Paul DeHart Hurd, "State of Precollege Education in Mathematics and Science," (May 12-13, 1982).

Members of the Commission

Lew Allen, Jr., Director, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California

Victoria Bergin, Associate Commissioner for General Education, Texas Education Agency, Austin, Texas

George Burnet, Jr., Chairman, Nuclear Engineering Department, Iowa State University, Ames, Iowa

William T. Coleman, Jr., Attorney, O'Melveny and Myers, Washington, D.C., Los Angeles, California, and Paris, France

William H. Cosby, Jr., Entertainer/Educator, Greenfield, Massachusetts

Daniel J. Evans, President, The Evergreen State College, Olympia, Washington

Donald S. Fredrickson, Scholar-in-Residence, National Academy of Sciences, Washington, D.C.

Patricia Albjerg Graham, Dean, Graduate School of Education, Harvard University, Cambridge, Massachusetts

Robert E. Larson, President, Systems Control, Inc., Palo Alto, California

Gerald D. Laubach, President, Pfizer, Inc., New York, New York

Katherine P. Layton, Teacher, Mathematics Department, Beverly Hills High School, Beverly Hills, California

Ruth B. Love, General Superintendent, The Chicago Board of Education, Chicago, Illinois

Arturo Madrid II, President, National Chicano Council on Higher Education, Washington, D.C.

Frederick Mosteller, Chairman, Department of Health Policy and Management, Harvard University, Boston, Massachusetts

M. Joan Parent, First Vice President, National School Boards Association, Foley, Minnesota

Robert W. Parry, Professor of Chemistry, University of Utah, Salt Lake City, Utah

Benjamin F. Payton, President, Tuskegee Institute, Tuskegee, Alabama

Joseph E. Rowe, Senior Vice President for Research and Development, Gould, Inc., Rolling Meadows, Illinois

Cecily Cannan Selby, Chairman, Board of Advisors, The North Carolina School of Science and Mathematics, Durham, North Carolina

Herbert A. Simon, Professor of Computer Science and Psychology, Carnegie-Mellon University, Pittsburgh, Pennsylvania

Additional Information on NSB Commission

The Executive Director of the NSB Commission is Dr. Richard S. Nicholson. Commission offices are located at 1800 G Street, N.W., Washington, D.C. 20550. The telephone number is 202/357-7700.

Chairman **Perkins**. Thank you very much.

We will withhold our questions until we hear the entire panel.

Dr. Norfleet, let me welcome you here today. Dr. Norfleet is president of Morehead State University, which happens to be in my congressional district. He is doing a wonderful job there as president. He built the institution up considerably. He has been very much interested in better math and science courses throughout the years, and I am delighted to welcome you here today, Dr. Norfleet.

STATEMENT OF MORRIS NORFLEET, PRESIDENT, MOREHEAD STATE UNIVERSITY

Dr. **Norfleet**. Thank you, Congressman Perkins, for the invitation to appear, and thank you, as members of the committee, for your efforts in addressing a problem that I feel is very acute. It is an honor to be here with my distinguished colleagues and express my concern along with theirs.

I have a prepared statement. I will not read it in its entirety but, rather, I would like to read portions and submit the statement for the record.

I am President of Morehead State University, an institution located in eastern Kentucky, enrolling 6,500 students, with approximately 48 percent of those we graduate going into teacher education.

We have a concern for the math and science area because we have seen it coming for a long time. Morehead State University was founded to address the problems of preparing teachers in the liberal arts programs, and we have responded to the technological education opportunities by developing a wide array of 2-year and preprofessional programs.

At the present time the shortage of certified teachers to teach the science and math students and the shrinking number of students entering these technical fields of study certainly threaten to undermine what my institution is attempting to achieve in eastern Kentucky. But it is also threatening our economic development throughout this country, the industrial base and the national security, as has been addressed here previously this morning.

As President Reagan has previously stated at the Convention of the National Academy of Science and the National Academy of Engineers in May of 1982, "failure to remain at the industrial forefront results in direct harm to the economy and the standard of living."

What is the problem? I see the problem taking at least 10 years to resolve to the level of satisfaction that I think has been expressed here this morning. As stated in the findings, section 601, part A of this Emergency Act, the problem is twofold. We need to increase the level of achievement of students at the elementary and secondary levels, as well as increase the supply and qualifications of teachers of math and science at the elementary and secondary level.

We can focus on the teachers at the high school level and do some immediate good, but there is a long-range impact that must come about, and it must start at maybe the first grade. Students must be taught the love of science, the love of mathematics, in order to get them to go into those fields. If we do not teach that love of the sciences, are we, in fact, forcing more dropouts by putting requirements on them at the high school level because they are afraid of the subject and they don't want to take them and they'll take an alternative path? Implicit in the goal to increase the level of achievement of our grade school children is that more of these students will pursue academic and/or career goals in math and science, thus providing us over the next decade and decades hence an adequate supply of well-trained teachers, scientists and engineers.

Part B of this act attempts to address the more short term problems of getting qualified teachers in those areas immediately to begin increasing the competency of these students. If we want to have an immediate impact, I am firmly convinced that we should provide funds to enable teachers to go back to school during the summer months to become qualified in the math and science areas.

Other areas of need have been identified here this morning. Certainly there are needs in those areas. But if you don't have enough money to do the total job adequately, then let's focus on a problem that we can handle. I have seen very few quail killed when you shoot at the covey. You have to focus on the bird, and that's what I think needs to be done in this particular act.

The current shortage of science and math teachers was predicted in the midseventies. We are now responding in the eighties. I feel two things primarily contributed to the current shortage—a trend that began in the sixties and carried into the seventies to downgrade or liberalize secondary school curriculums which reduce science and math requirements, and second, the low pay associated with teaching at the high school level.

Yes; we have had a problem. I have been involved in teacher education and I saw modern math come on the scene. I saw it taught at the university level, and I saw it rejected. I'm not sure how fully we ever made the transition to modern math, and I raise the question but I don't have the answer. Are we still half way between something and we don't know where we are in the teaching of mathematics? I think Dr. Ikenberry very clearly pointed out the need for curriculum revision and evaluation in these areas.

As relates to curriculum liberalization, colleges and universities are not blameless, either. We also weakened our curriculum to permit students more freedom of choice in course selection and pre-electives. More times than not, students opted for courses other than in science and mathematics. I can recall when we added a requirement that teachers had to take an additional 3 hours of mathematics to become certified in elementary education, the great hue and cry went up in our institution that we were forcing them out. They didn't want to take the additional course.

The increase in the number of students we have in remedial science and math courses attest to this fact, and Dr. Ikenberry addressed that.

There has been numerous times over the years when we have been criticized for teaching remedial courses on our campuses. It is my contention that if a student comes to college our job is to take him from where he is to where he should be at the time he graduates. That has meant providing remedial education to those students. In our country we call it putting the jam on the shelf where the student can reach it. But the reality of the need for these remedial courses is evidenced that the achievement level of science and math students we receive from the secondary schools is not adequate for them to do college level work. Those students who want to enter a course of study in college that requires somewhat more than just minimum competency in science and mathematics take our remedial courses. Many students, though, try to avoid only but the minimum science and math requirements.

This trend must be reversed, and it can be done so with concentrated, cooperative effort on every front. We in Kentucky, as have other States, have now taken steps to upgrade our academic requirements for unconditional admission to a public institution, whereas before graduation from high school got you into college. Beginning in 1987, high school students must complete a minimum of 20 high school credits with a prescribed curriculum in the science and math areas. Our State Board of Education only this month approved the increased number of high school credits recommended as the precollege curriculum. The State Council on Higher Education also, in January of this year, approved these new precollege standards as a minimum admission requirement for the State's eight public 4-year institutions.

The irony of these increases is that we in Kentucky, with our much needed public policy on precollege curriculum, have at the time of a teacher shortage in the science and math areas actually increased the demand not only for more science and math teachers but better ones, also. However, regardless of the immediate problem this poses for our State, the alternative was to do nothing and continue the present trend of having college freshmen with less than a basic competency in the science and math field.

The second reason for this shortage is the low pay associated with teaching versus private industry. Technology has changed the way we all work and think, and it is absorbing many of the science and math students we do produce, and understandably so. The President of the National Council of Teachers of Mathematics is quoted as saying:

> Math teachers coming out of college already realize that $12,000 paid to a beginning teacher is a lot less than $20,000 they could earn in the first year at some computer firm. In addition, the public's indifference to the plight of teachers, the low pay, the crowded classrooms, the poor facilities, is a sign for many students to stay away from the teaching fields.

In a National Science Teachers Association survey conducted in 1981, among newly employed science and math teachers, 50.2 percent were unqualified, and the results are particularly bad in States where high technology industries require the best trained science and math teachers.

I could go into the teacher shortage facts State by State, but I want to address specifically our problem in Kentucky. In Kentucky, over the 10-year period from 1971 to 1981, 905 science majors and 786 mathematics majors were certified to teach at the secondary level. This represents production from 8 public and 15 private institutions in the Commonwealth. In 1971, the Commonwealth of Kentucky certified 153 science teachers. In 1980–81, it dropped to 53. In math, the Commonwealth certified 137 teachers in 1973–74, and only 44 in 1980–81. As a result of all these shortages, school districts are forced to use unqualified secondary teachers to teach science and mathematics classes that their students must have. When one looks at the declining level of achievement scores of secondary school pupils in the field of science and mathematics, the results of having uncertified teachers is obvious.

Here is what is happening in other States: 55 percent of the teachers of mathematics in North Carolina were certified to teach mathematics in 1981; Missouri, 40 to 80 percent of the prospective teachers graduating from the Missouri Teachers' Institute will be certified—and on and on showing the shortage.

It was estimated by the Kentucky Academy of Science that approximately 35,000 youngsters are being taught in the Commonwealth of Kentucky by uncertified teachers in the science and math fields. The State of Maryland estimated that 50,000 students were being taught by teachers out of their field. A review of the facts of the National Council of Teachers of Mathematics will quickly give you a true picture of what is happening in our secondary schools. Is there any doubt why the achievement level in science and math has declined?

I feel that H.R. 30 is a step in the right direction. For whatever reason, the achievement level of students in the math and science competencies have declined. I think the emergency act will assist the State and its local school districts in developing plans and implementing programs that will lead increasingly to the achievement level of our elementary and secondary students in science and math. However, part B, as it relates to postsecondary education and assistance, is as important as part A. As critical as the need to get more current teachers certified to teach in the science and math competencies is the need to modernize and upgrade the facilities and equipment in our postsecondary laboratories and classroom not as great. Dr. Ikenberry spoke to this point, and I would not suggest we get all the technologies involved with this bill, but I think this is an issue that must be addressed immediately because we are teaching our prospective and future students and engineers to go out in a field where they will face equipment that they have never had any instruction on at all in the classroom, that we cannot keep abreast of the change of technology.

This coming summer Morehead State University, in an effort to remedy the shortage of teachers in math and science in the Commonwealth, is initiating a two-summer sequence of courses leading to a minor in mathematics and certification to teach mathematics at the secondary level. The sequence, however, will not all be taken in one summer. It consists of 23 semester hours of math and 3 semester hours of programing in the basic languages. The summer institute portion of part B will assist us in developing similar types of programs.

In addition, Morehead State University developed special inservice teacher training programs in conjunction with our local school districts to upgrade the quality of education. Part B of the act that relates to the summer institute really excites me. I feel it is properly focused. Let's prepare those teachers who are already in the field and retrain them because they are there, and some of them may desire to go into this area. Some are already in the area. This will help them do so.

The Commonwealth of Kentucky has also made available loans of $2,500 to students whom, upon entering their sophomore years, enters a math teaching certification curriculum. For each year taught after graduation, 1 year of the loan will be forgiven. Certified teachers in other fields who attend the summer school to become certified to teach mathematics will qualify for up to one-third of the loan amount to be forgiven.

If I have one concern about the Emergency Act, it relates to the relatively small amount of funds authorized for strengthening educational research and development and upgrading laboratory equipment and facilities.

If I could identify the area in my institution that is 10 years behind in the State of the art of equipment and facilities, it is in the area of science and mathematics, particularly in the computer sciences.

When we talked about salaries a while ago, I cannot keep instructors in the area of computer science. I cannot compete with business and industry for those individuals. When I get a good professor, he is with me for 2 to 3 years and he immediately leaves for a salary in excess of $10,000 more than I can pay that individual.

Federal programs in the past enabled us to keep up in the technologies in the many areas, and since many of these have been eliminated or cut back, our capabilities to keep up have diminished. We had the old title VI, part A and part B—part A referred to media equipment and part B to scientific equipment. The National Science Foundation had an equipment program that has been eliminated. Therefore, we have no access to those funds.

I think I can safely say that many of my fellow college and university presidents support H.R. 30. I have talked to many of my colleagues in the American Association of State Colleges and Universities, which has a membership of 350 regional universities, like Morehead State, and I know the association is firmly behind this legislation. The results will be tangible, and if I could summarize by saying, No. 1, focus on training and retraining of those already teaching, the high school and elementary teachers, and encourage more to go into the field of teaching.

There is a provision in this piece of legislation for teachers to be on leave of absence, to be associated with a research laboratory, where they can get firsthand knowledge of what is happening in the field and take it back to the classroom. We are divorcing our classrooms from those research laboratories and they do not know what's going on.

Do something for facilities and equipment, so that we can adequately train the teachers. We need to be encouraged some way to get more scholars on our campus, scholars from business and industry to bring the real world on campus and into the classrooms of our public, elementary and secondary classrooms.

We need to develop this awareness program, and one of the things that I am working on at the present time is to develop an awareness program—and it will probably start at the second grade level, inviting a group of elementary teachers to campus for a period of time, simply to acquaint them with the new scientific approaches in all fields. It will be a shotgun approach, but it's an awareness attempt only. So that when they go back to the classrooms, and that second grade student comes in after having watched Nova the night before, that teacher can be at least coherent in talking to the student about what he saw on television. This will be an awareness attempt that will go on for a period of time, year by year, bringing in a small number with intensive instruction in the total area.

Congressman Perkins and members of the committee, thank you for giving me an opportunity to address this important issue. Morehead State University stands firmly behind any attempt that this committee and the legislature envisions in acting to remedy the problem.

Thank you.

[The statement of Dr. Norfleet follows:]

PREPARED STATEMENT OF MORRIS L. NORFLEET, PRESIDENT, MOREHEAD STATE UNIVERSITY

INTRODUCTION

I'm Morris Norfleet, President of Morehead State University. MSU is a public institution of 6,500 students located in eastern Kentucky. We serve primarily twenty-two northeastern and eastern Kentucky counties. Twenty-one of these counties are in Appalachia. I'm here today to speak in support of House Resolution 30, the Emergency Mathematics and Science Education Act. The legislation is an attempt to provide assistance to improve elementary, secondary and post secondary education in mathematics and science.

MSU was founded as, and is still, an institution primarily focused on providing teachers to our service area. Along with our other Liberal Arts programs, we have, of course, responded to the demand for technological educational opportnities by developing a wide array of 2 year and pre-professional programs. We in eastern Kentucky are acutely threatened by the shortage of science and mathematics teachers and the relatively small number of students matriculating in these fields today.

The shortage of certified teachers to teach the sciences and mathematics students; and the shrinking number of students entering these technical fields of study, certainly threatens to undermine what my institution is attempting to achieve in eastern Kentucky, but is also threatening to the economic development, the industrial base and national security of this country. As President Reagan has previously stated at the Convocation of the National Academy of Science and the National Academy of Engineering in May of 1982, "Failure to remain at the industrial forefront results in direct harm to the economy and standard of living."

PROBLEM

As stated in the "finding" Section 601, Part A of this Emergency Act, the problem is twofold. We need to increase the level of achievement of students at the elementary and secondary level as well as increase the supply and qualifications of teachers of mathematics and science at the elementary and secondary level. Implicit in the goal to increase the level of achievement of our grade school children is that more of these students will pursue academic and/or career goals in the mathematics and sciences, thus providing us over the next decade and decades hence an adequate supply of well-trained teachers, scientists and engineers. Part B of this Act attempts to address the more short-term problem of getting qualified teachers in these areas immediately to begin increasing the competency of these students.

The current shortage of science and math teachers was predicted in the mid 1970's. I feel two things primarily contributed to the current shortage: (1) A trend that began in the 60's and carried into the 70's to downgrade or liberalize secondary school curriculums which reduced science and math requirements, and (2) the low pay associated with teaching at the high school level.

As relates to curriculum liberalization, colleges and universities are not blameless either. We also weakened our curriculums permitting students more freedom of choice in course selection. More times than not, students opted for courses other than in science and mathematics. Many students coming to us from the secondary schools lack the basic skills to deal with college level science and mathematic courses. The increase in the number of sudents we have in remedial science and math courses attest to this fact. There have been numerous times over the years when we have been much criticized for teaching remedial courses on our campuses. But the reality of the need for these remedial courses are evidence that the achievement level of the science and mathematics students we receive from the secondary schools is not adequate for them to do college level work. Those students that want to enter a course of study in college tht requires somewhat more than just the minimum competency in science and mathematics take our remedial courses. Many students though try to avoid only but the minimum science and math requirements.

This trend must be reversed. The students entering our colleges and universities must have stronger science and math backgrounds; not only to matriculate normally but to enter teaching fields in the sciences and mathematics or the non-teaching science and mathematic fields to meet the demand of government and industry.

Quoting John B. Slaughter, Director of the National Science Foundation, "only about ⅓ of high schools require more than one year of math or science for graduation. Colleges and universities have reduced the number of subjects they require for admission. Continuing to quote: What is so worrisome about this trend is that students who take no math or science after their tenth school year have effectively eliminated science or engineering as careers. Moreover, as society becomes more dependent on technology, technically illiterate students may be forsaking the ability to be fully productive citizens in many ways of life." End quote.

We in Kentucky, as have other states, now have taken steps to upgrade our academic requirements for unconditional admission to a public institution. Whereas before, graduation from high school got you in college. Beginning in 1987, high school students must complete a minimum of 20 high school credits with a prescribed curriculum in the science and math areas. Our state board of education only this month approved the increased number of high school credits recommended as the pre-college curriculum. The state Council on Higher Education also in January of this year approved these new pre-college standards as the minimum admission requirement for the state's eight public four-year institutions.

The irony of these increases is that we in Kentucky, with our much needed public policy on pre-college curriculum, have at a time of a teacher's shortage in the science and math area actually increased the demand for not only more science and math teachers, but better ones also. However, regardless of the immediate problem this poses for our state, the alternative was to do nothing and continue the present trend of having college freshmen with less than a basic competency in the science and math fields.

The second reason for the shortage is the low pay associated with teaching vs. private industry. Technology is changing the way we all work and think, and is absorbing many of the science and math students we do produce, and understandably so. Max Sobel, president of the National Council of Teachers of Mathematics, is quoted as saying, "Math teachers coming out of college already realize that the $12,000 paid to a beginning teacher is a lot less than the $20,000 they could earn in the first year with some computer firms. In addition, the public's indifference to the plight of teachers, the low pay, the crowded classrooms and the poor facilities are a sign to many students to stay away from the teaching fields."

In a national science teacher's association survey conducted in 1981 by James Shymansky of the University of Iowa—among newly employed science and math teachers, 50.2 percent were unqualified, and the results are particularly bad in states where high technology industries require the best trained science and math personnel.

TEACHER SHORTAGE FACTS

This is not a fabricated shortage. While the nation's colleges and universities are producing enough secondary teachers in other areas, we have not been able to meet the demand for science and mathematics teachers, especially in the science fields of physics, chemistry and earth science. As college administrators, we know we've been producing more elementary and secondary teachers than are needed in today's market because of declining enrollments. But, the decline in science and math teachers has already exceeded the enrollment decline by a factor of three, according to testimony given by Sarah E. Klein, President of National Science Teachers' Association, given before the Committee on Human Resources of the U.S. Senate.

If I may take the time, I want to use a few facts prepared by the National Council of Teachers of Mathematics. Since 1972, there has been a 77 percent decline in the number of secondary-level mathematics teachers prepared in 600 teacher-trainer programs nationwide. Among newly employed science and mathematics teachers, 50.2 percent were judged by principals to be unqualified to teach in those fields, but had been employed on an emergency basis because school officials could not find qualified teachers. In the Pacific States, according to the principals, the ratings of unqualified personnel jumped to 84 percent. (Education Week, March 31, 1982.)

To again quote from the testimony of Sarah E. Klein, "only 55 percent of the graduates prepared to teach mathematics actually entered the teaching profession. Almost five times more science and mathematics teachers left teaching in 1980 for employment in non-teaching jobs than left due to retirment. If the present exodus of qualified science and mathematics teachers from secondary schools continues, the nation will have a net loss of 35 percent by 1992.

STATE-BY-STATE ANALYSIS

A 1981 study by Trevor G. Howe and Jack A. Gerlovich, titled "National Survey of the Estimated Supply and Demand of Secondary Science and Mathematics Teachers" indicated that in 43 of the 45 U.S. states reporting, there was a shortage or critical shortage of secondary mathematic teachers in 1981. This study also indicates that 40 states had shortages or critical shortages of physics teachers, 37 states had shortages or critical shortages of chemistry teachers and 31 states have a shortage or critical shortage of earth science teachers.

In Kentucky over the 10 year period, 1971–72 to 1980–81, 905 science majors and 786 mathematics majors were certified to teach at the secondary level. This represents production from 8 public and 15 private institutions in the Commonwealth. In 1971–72, the Commonwealth of Kentucky certified 153 science teachers; in 1980–81 it dropped to 53. In math, the Commonwealth certified 137 teachers in 1973–74 and only 44 in 1980–81.

As a result of all these shortages, school districts are forced to use unqualified secondary teachers to teach the science and mathematic classes that their students must have. When one looks at the declining level of achievement scores of secondary school pupils in the field of science and mathematics the result of having uncertified teachers teaching is obvious. Here's what's happening in a few of your own states. Again, from facts compiled by the National Council of Teachers of Mathematics.

In North Carolina: In 1979–80 only 55 percent of the teachers of mathematics in the state were certified to teach mathematics. (Mathematics Teacher, December 1981.)

In Missouri: Only about 40 of the 80 prospective mathematics teachers who will graduate from Missouri's teaching institutions are expected to be teaching the following fall, although at least 200 vacancies are expected in the state. (Kansas City Times, 21 May 1982.) There was a 43 percent increase in the issuance of emergency certification in 1979 vs 1978. (Mathematics Teacher, March 1981.)

In New York: The nation's second most populous state had only 32 college graduates planning to teach junior or senior high school mathematics in 1982, down from 715 in 1975.

In New Hampshire: Only one college graduate in the state in 1982 is planning on a career in mathematics teaching. (Christian Science Monitor, 12 July 1982.)

In California: Of the more than 400,000 students in California's public four-year institutions in the spring of 1982, only 97 were preparing to be secondary mathematics teachers. (Phi Delta Kappan, September 1982.)

In Connecticut: Connecticut's 14 teacher training programs produced only 28 mathematics endorsed candidates for the State's 161 mathematics vacancies. Only 59 percent of the teachers in grades 6–8, 7–9 and 7–8 mathematics departments possess a 7–12 mathematics endorsement. (Department of Education, State of Connecticut, "A Narrative Summary of the 1982 Questionnaire Regarding the Need for Mathematics Teachers.")

In New Jersey: The State Department of Education has declared an emergency shortage of mathematics teachers in 17 of New Jersey's 21 counties. This emergency designation permits districts to use unlicensed teachers—Some without bachelor's degrees—to teach the subject. (Star-Ledger, September 1982).

It was estimated by the Kentucky Academic of Science that approximately 35,000 younsters are being taught in the Commonwealth of Kentucky by uncertified teachers in the science and math fields. The State of Maryland estimated 50,000 students were being taught by teachers out of their field. A reveiw of the facts from the national council of teachers of mathematics will quickly give you a true picture of what's happening in our secondary schools. Is there any doubt why the achievement levels in science and math have declined?

SUMMARY AND CLOSE

I feel House Resolution 30 is a step in the right direction. For whatever reasons, the achievement levels of students in the mathematics and science competencies have declined. I think the emergency act will assist the State and its local school districts develop plans and implement programs that will lead to increasing the achievement level of our elementary and secondary students in science and mathematics. However, part B as it relates to post secondary assistance is as important as part A.

As critical as the need to get our current teachers certified to teach in the science and math competencies: Is the need to modernize and upgrade the facilities and equipment in our post secondary laboratories and classrooms.

This coming summer, MSU in an effort to remedy the shortage of teachers in mathematics in the commonwealth is initiating a two summer sequence of courses leading to a minor in mathematics and certification to teach mathematics at the secondary level. The sequence (not all in one summer) consists of 23 semester hours of mathematics and 3 semester hours of programming in the basic language. The summer institute portion of part B will assist us in developing similar type programs. In addition, MSU is developing special inservice teacher training programs in conjunction with our local school superintendents to upgrade the quality of instruction.

Part B of the act that relates to the summer institute really excites me. I feel it is properly focused. It is focused on a segment of our population—those people who have already chosen teaching as a career—where results are, in my opinion, assured and immediate.

The Commonwealth of Kentucky has also made available loans of $2,500 to students whom upon entering their sophomore year enters a mathematics teaching certification curriculum. For each year taught after graduation, a year of the loan will be forgiven. Certified teachers in other fields who attend summer school to become certified to teach mathematics will qualify for up to ⅓ of the loan amount.

If I have one concern about the emergency act, it relates to the relative small amount of funds authorized for "strengthening education research and development", and "upgrading laboratory equipment and facilities." If I could identify the one area in my institution that is 10 year behind in state of the art equipment and facilities, it's in the area of science, mathematics, computer science and the other technologies. Federal programs in the past enabled us to keep up; since many of these have been eliminated or cut back, our capabilities to keep up have diminished. Without the proper equipment and facilities, we still face an uphill battle to alleviate the "finding" of section 601 of this act.

I think I can safely say that many of my fellow college and university presidents support House Resolution 30. I encourage your support of this legislation. The results will be tangible and will be obvious to us all. Thank you for permitting me to appear here today.

Chairman **Perkins**. Thank you very much, Dr. Norfleet, for giving us your excellent testimony.

Our next witness is Nolen Ellison, chancellor, Cuyahoga Community College. We are delighted to welcome you here. You have already been introduced by Mr. Stokes.

STATEMENT OF NOLEN M. ELLISON, CHANCELLOR, CUYAHOGA COMMUNITY COLLEGE

Dr. **Ellison**. Thank you, Mr. Chairman, and members of the committee, my colleagues at the table. I will try not to repeat a good many of the facts that you have heard from my colleagues that really represent the entirety of higher education in America today and our broad-based concern about the condition of science and math education and the condition of the public education system with respect to future directions in the country.

I am here today speaking on behalf of the Joint Commission on Federal Relations, however, the American Association of Community and Junior Colleges, and the Association of Community College Trustees. Additionally, I am this year on a half-year sabbatical leave, funded by the Kellogg Foundation, to help the 1,230 community colleges and technical colleges across the country to reassess our resources as institutions and the great challenge of putting America back to work as soon as possible. So I represent a unique sector of higher education today, and I should begin with a couple of facts that I would suspect the committee is aware of, but I want to reiterate them.

First of all, I would point out that a community or technical or junior college today in America is within reasonable commuting distance of more than 90 percent of all Americans in our country. Second, that community and technical and junior colleges are low cost, with an average tuition of $501 a year in the public sector. Representative Stokes mentioned $16 a credit hour at Cuyahoga. That fee is about average, a little more than average across the country today.

Seven point one percent of all U.S. adults 18 years old and older are enrolled in community, technical and junior colleges in the 1980–81 year; 4.9 million credit enrollments in the fall of 1980; 2.4 million in other semester and tri-mester and summer sessions. Forty percent of all undergraduate students in colleges were enrolled in community, technical, and junior colleges in the fall of 1981. I imagine if I were to add the enrollments at the branch campuses, the university branch campuses of Ohio, which does not have a comprehensive community college system, and the branch campuses in Kentucky, that figure would even be much greater.

Community and technical and junior colleges prepare people for employment in over 1,400 different occupations, 263 alone in the allied health field. Community, technical, and junior colleges prepare people for transfer to the 4-year colleges and universities, and many of them, like my institution, match perfectly with Case Western Reserve University and with Cleveland State University in what we call two-plus-two programs that provide the bridge opportunity for many people who cannot afford to go on to the university immediately but come to us because of our broad based programs in the science and math areas and because we provide tremendous support services for those students who need extra help, who came from the high schools ill-prepared.

Those facts then lead me to suggest a couple of things. When Representative Skelton talked about the skilled trades, when Representative Brown mentioned to focus on the tip of the iceberg, that the National Science Foundation was not enough, that in this country today we must be concerned about the broad base of our citizens and the ability to function effectively in society as we know it, and certainly as we move to the high technology areas.

I listed several areas of major projects underway now in community and technical colleges across the country that relate specifically to the topic we're talking about: advanced computer applications, microelectronics, medical technologies, advanced manufacturing, CADCAM systems, advanced office technologies, many of these are programs, a part of the 252 job titles listed in the handbook on occupations, where more than half of those titles will not require in the years ahead a 4-year college degree. And yet the technician base for training, the technician base to support business and industry, the technician base in our country today will be educated probably, at least step one, in the 2-year community, junior, and technical colleges.

It is gratifying to know that the committee has focused this issue in terms of how H.R. 30 addresses the question of critical shortages in teacher education and training. Our concern would be also that the improvement of science and math education generally, not just the question of teacher training, and the utilization of business industry resources, as one of the key links to meeting this scientific gap that we now face would be a part of our thinking and your thinking here today.

In my testimony that will be entered into the record, in table one of that testimony of facts, you will note that a number of 2-year community and junior colleges reporting on critical shortages or shortages suggests that over 90 percent of our colleges are hurting for computer instructors today. Some 433 responding schools to a most recent survey by our president, Dr. Dale Parnell, who is the president of the AACJC, of 433 responding schools, roughly one-half of the public 2-year colleges in America, some 77 percent are also hurting in the area of electronics instructors, those who can function effectively in the training programs that we have.

Shortages run 40 percent or higher in both math and physics, and 38 percent reported shortages in the other high-tech areas. In the breakdown of computer science instructor shortages by region, table 2 in my summary, all the responding colleges in region II—New York and New Jersey—showed they need critical help in those areas.

The testimony that is entered into the record is buttressed by statements from Peter Blake, the Director of the International Robotics Institute, that points out that unless we are able to provide both the manufacturing base and the technological research base, and also the technician operation base for that industry, that we will continue to fall even further behind. You had the facts brought before you this morning.

In the community colleges, we look at this crisis with the same sense of urgency and gravity that TRW economist Dr. Pat Choate ascribes to it in his penetrating monograph, "Retooling the American Work Force: Toward a National Training Strategy", in which he observes:

> The speed and force of . . . change will be awesome. Consequently, millions of jobs and workers will become obsolete. . . . In this decade virtually all of the nation's workers, most of whom are now employed, will need to be retrained or have their skills sharpened.

We contend that much of that training and retraining is going to go on in low-cost, close-to-home community institutions that are stationed now all across our nation.

We hope that every Member of Congress would have access to that document, because we believe that it represents very strongly a view that 2-year community and junior and technical colleges support.

A commitment to human capital and skill development on the scale we are talking about ought to take the form, we believe, of a broad national policy by which the currently fragmented Federal programs that foster employment and skill development, including the Vocational Education Act, can be more effectively focused on the Nation's critical skill shortages.

Governor Pierre S. du Pont, IV of Delaware put the challenge aptly last week at the National Press Club when he said—and I quote—". . . a comprehensive national employment policy must reach the same level of priority in the eyes of government as national defense." So, the bridge between the comments made by the Representatives earlier today and the comments of this panel with respect to not only science and math education but, indeed, training people to go to work in our businesses and industries today, are bridged in the concept that, indeed, a national human resource reinvestment must be made.

Mr. Chairman, your bill, H.R. 30, points us in the direction of building such a policy, I believe, toward building the two-pronged program by which the crisis in productivity in this Nation can be met. One prong must be the revitalization of math and science instruction in the elementary and secondary school levels, as prescribed in your bill. The second prong must be an equally vigorous initiative at the adult education level, focused on the demand side of the employment market.

We have listed in the testimony, and we will attach to the testimony, a number of specific examples that your committee can be led by, examples that are working today in bridge institutions called community, junior, and technical colleges.

Representative Miller's bill of the last Congress, H.R. 5820, addressed the challenge from the demand side, and the Association of Community College Trustees provided written comments to your California hearings which support the concept addressed. If industry is given incentives to offer the first piece of the training dollar, then taxpayers will have stronger assurances that displaced workers and the unemployed are being trained for real jobs.

In your December markup of H.R. 7130, Mr. Chairman, you voiced alarm that the National Science Foundation was not responsive to initiatives in community colleges, technical colleges, and smaller universities, and that it had done little to advance the development of technician training. We echo that concern. NSF can and should do much more to expand the Nation's technician skill base. Just as the U.S. competitive advantages in industry have dwindled away over time because of the neglect of the skill base, any edge we may still enjoy in technological and scientific discovery also will be lost over time unless we rebuild the skill base that will operate the systems that are now being put in place.

In revitalizing the science and math programs at every level of education, the community colleges already are a strong partner, and a natural partner, between public education, elementary and secondary, and most of our 4-year colleges and universities, and increasingly between business and industry—just one more example.

Representative Stokes mentioned the NASA [Lewis], Case Western Reserve, Cleveland State University, Cuyahoga Community College, and the local public school system bridge. That project is working because we have asked NASA scientists and scientists in business and industry in the greater Cleveland community to come into our classrooms directly, and they provide now a large cadre of our part-time faculty in hard-to-fill full-time jobs. That project is working and it is one that will be an example across the country, of business, industry, research center, university, community college partnerships.

Dr. Ikenberry mentioned the PLATO project. Mr. William Norris, chief executive officer of Control Data Corporation, a company that still handles at least the marketing end of the program logic machine called PLATO. We have entered into a 3-year agreement that we are at the end of now, in which that company paid half the cost for the continued R&D development and utilization of the PLATO system. Mr. William Norris is a member of the President's Task Force on Private Sector Initiatives, and on his visit to Cuyahoga Community College less than a month ago, where we are now in the process of defining a new 5-year agreement to do many of the things that President Ikenberry mentioned, but which needs expansion at this point, it is the bridge relationship and those kind of partnerships that will help us bridge the gap that I believe and we believe today exists in our country.

Let me conclude, Mr. Chairman, by saying that we view H.R. 30 itself and the support of your committee as an essential element in the overall policy on human resource development. The more pressing needs of community colleges are concentrated largely in two areas—equipment and professional development—and those have already been mentioned.

We applaud your program offering matching grants to help colleges acquire state-of-the-art equipment. We urge you to consider more than what is in that bill today, in part B. That has already been stated.

It is our earnest hope, Mr. Chairman, that you and this committee can work with the Ways and Means Committee to legislate tax benefits to industry that would encourage them, indeed, to help education on three fronts—and I would conclude with these three points:

By expanding their fits of state-of-the-art equipment for use in occupational programs. We will never be able to acquire state-of-the-art equipment in all of our institutions today. Much of that is going to come through cooperation with business and industry.

Two, allowing professional personnel released time, on a systematic basis, to serve as adjunct faculty in math, science and high technology courses. And I'm not so sure, from our example of our NASA agreements and relationships in the greater Cleveland area, that that kind of partnership bridge ought not be built into the act, so that government workers in the research area and in the private industry area might see themselves being part of the solution to our massive education problem in the short run.

And third, providing summer or off-term employment for math, science, and high tech instructors, so that they stay with their teaching careers while they attempt to stay versed in the state-of-the-art equipment and new programs.

If you wish further comment, Mr. Chairman—I regret belaboring the point, but we think this unique sector of higher education today and the partnerships that we are beginning to build—because turf is not our problem today. My college is a county institution. Taxpayers pay part of the bill for running our institution, and we can afford to be partners in the turf and not defenders of the turf.

Thank you.

[Prepared statement of Nolen Ellison follows:]

PREPARED STATEMENT OF NOLEN M. ELLISON, CHANCELLOR, CUYAHOGA COMMUNITY COLLEGE DISTRICT, CLEVELAND, OHIO

Mr. Chairman, it is gratifying to the education community to see you and this Committee moving with such dispatch on legislation that addresses some of the root causes of our national crisis in productivity. If our Nation is to overcome relative and competitive skill slippages that threaten our global leadership in technology and industrial production, then the kinds of initiatives you are formulating in H.R. 30 must move to the very top of our national agenda.

I hope all of us here do agree that these slippages constitute a national crisis. Our declining skill base clearly is a central factor in the current recession, and if the slippages are not reversed, they could lead to a serious erosion of both our standard of living and the traditional American way of life.

Of course, to rebuild the skill base, we must overcome the crippling shortages of qualified teachers in science and math. These shortages are hurting the community colleges, as well as the elementary and secondary schools. Dale Parnell, President of the American Associaton of Community and Junior Colleges, has been making a survey to gauge these shortages. The two tables that follow show the severity of the problem.

Adding together on Table 1 those that report either "critical shortages" or "shortages," we see that nearly 90 percent of the colleges are hurting for computer instructors. Of 433 responding schools—roughly one-half of the public two-year colleges—some 77 percent also are hurting for electronics instructors.

Shortages run 40 percent or higher in both math and physics—and 38 percent reported shortages in other "high tech" fields. In the breakdown of computer science instructor shortages by region, Table 2, all the responding colleges in Region II (New York and New Jersey) show they need help.

TABLE 1.—INSTRUCTOR SHORTAGES IN COMMUNITY COLLEGES

[Total response by subject, in percent]

	Critical shortage	Shortage	Adequate	Surplus	Other
Computer sciences	52	37	8	0	No response, 3.
Electronic technology	31	36	15	1	No response, 13; not applicable, 4.
Mathematics	7	35	47	3	No response, 8.
Earth sciences	1	9	63	6	No response, 18; not applicable, 3.
Physics	6	34	44	2	No response, 14; not applicable, 1.
Chemistry	3	24	60	3	No response, 10.
Business	3	27	55	6	No response, 9.

Note.—Other: 34 percent of the respondents indicated shortages in "other" subjects. Nursing—28 percent; Other allied health fields—20 percent; High-tech fields—38 percent; Other—14 percent.

Source: AACJC.

TABLE 2—RESPONSE BY REGION

[Percent]

Computer science	Critical shortage	Shortage	Adequate	Surplus	Other
Region I (Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island, Vermont/5%) [1].	45	45	9	0	
Region II (New Jersey, New York/7%) [1]	70	30	9	0	
Region III (District of Columbia, Maryland, Pennsylvania, Virginia, West Virginia/9%) [1].	54	41	5	0	
Region IV (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee/20%) [1].	63	29	7	0	No response, 1%.

TABLE 2—RESPONSE BY REGION—Continued

[Percent]

Computer science	Critical shortage	Shortage	Adequate	Surplus	Other
Region V (Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin/19%)[1].	51	37	9	0	No response, 4%.
Region VI (Arkansas, Louisiana, New Mexico, Oklahoma, Texas/9%)[1].	40	48	10	0	No response, 2%.
Region VII (Iowa, Kansas, Missouri, Nebraska/7%)[1]	38	47	12	0	No response, 3%.
Region VIII (Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming/4%)[1].	44	44	6	0	No response, 6%.
Region IX (Arizona, California, Hawaii, Nevada/11%)[1]...	54	33	11	0	No response, 2%.
Region X (Alaska, Idaho, Oregon, Washington/6%)[1]	33	48	11	0	No response, 7%.

[1] — /%—Number of region responses/total responses.

Source: AACJC.

We have learned from Peter Blake, Director of the International Robotics Institute, that his industry alone expects in the next six or seven years to grow from a $140 million a year business into an industry grossing $2.5 billion annually. He notes that this means a tremendous displacement of workers and heavy retraining for jobs, nearly all of which will require a math base and technical skills but not a bachelor's degree. He also reports critical shortages of instructors in programs feeding those job needs.

What our Nation needs today more than anything else, in our judgment, is a "moon shot" commitment to the development of its human capital.

Looking back on the boost that Congress gave the sciences in the wake of Sputnik, it seems a terrible irony that now, barely a generation later, secondary schools in almost every State are searching in vain for teachers qualified to give their science and math courses. Though that boost undoubtedly has been responsible for keeping the United States in the forefront of technological and scientific discovery, we now need initiatives that will mobilize our larger skill base.

In the community colleges, we look at this crisis with the same sense of urgency and gravity that TRW economist Pat Choate ascribes to it in his penetrating monograph, "Retooling the American Work Force: Toward a National Training Strategy," in which he observes: "The speed and force of . . . change will be awesome. . . . Consequently, millions of jobs and workers will become obsolete. . . . In this decade virtually all of the nation's workers, most of whom are now employed, will need to be retrained or have their skills sharpened."

We hope every Member of Congress will read the Choate monograph.

The Association of Community College Trustees and the American Association of Community and Junior Colleges have in the past 18 months launched several initiatives aimed at bolstering American productivity, and at encouraging more sharply focused national policy. ACCT and AACJC last July closed ranks in the policy arena by forming their Joint Commission on Federal Relations, chaired by Judith Madonia, who also is Chairman of the Board of Lincoln Land Community College in Springfield, Illinois. The foremost need in legislation, in the view of this Commission, for which I am privileged to testify here, lies in focusing federal initiatives to form a cohesive national policy on comprehensive human resource development.

The two Associations also are working together to promote public-private partnerships. In fact, we are doing it on several fronts, as the accompanying brief on "Putting America Back to Work" will show.

We emphasize that these initiatives spring as much from the grassroots as from the Associations. In the last decade, scores of community and technical colleges have been reaching out to local industry to develop and staff what we call "employer specific" courses. Such courses provide training tailored to each company's defined skill needs.

The Business-Industry Community College Coalition, led by ACCT, has been working closely with the White House and the President's Task Force on Private Sector Initiatives to make community colleges still more proactive in responding to the private sector and to the skill needs of industry, labor and government alike. Colleges are encouraged by BICCC to establish local Business-Industry Councils, to ensure themselves of continuing guidance from the private sector.

In sheer numbers of learners served, the community colleges have in the last decade become the largest branch of American higher education. Of the more than five million learners enrolled in the credit and degree programs at two-year colleges, almost two-thirds, or well over three million, are taking techical and occupational courses. Although it is harder to gauge the non-credit population, the number of adults taking community college courses without credit could be equally great.

In some states, like Washington, the community colleges have more students holding bachelor's, master's or even doctor's degrees who are learning a job skill than are enrolled in any graduate school program in the State. An analysis of the community college program data collected by the National Center for Educational Statistics suggests that the total population pursuing vocational courses in the two-year colleges exceeds 4.2 million.

A commitment to human capital and skill development on the scale we are talking about ought to take the form, we believe, of broad national policy by which the currently fragmented federal programs that foster employment and skill development, including the Vocational Educational Act, can be more effectively focused on the Nation's critical-skill needs.

Governor Pierre S. du Pont IV of Delaware put the challenge aptly last week at the National Press Club, when he said: ". . . a comprehensive national employment policy must reach the same level of priority in the eyes of government as national defense . . ."

Mr. Chairman, your bill, H.R. 30, points us in the direction of building such a policy—toward building the two-pronged program by which the crisis in productivity can be met. One prong must be the revitalization of math and science instruction in the elementary and secondary schools, as prescribed by your bill. The second prong should be an equally vigorous initiative at the adult level, focused on the demand side of the employment market, by which we can turn out the technicians that industry must have to meet global competition. Our point about demand is this: Up to now, the federal programs have been largely oriented toward the supply side, toward recylcing the needy and the unskilled into training for so-called "entry level" jobs that in many cases prove not to exist. The Choate monograph makes the point graphically in these passages: ". . . the first step is to ensure that almost all the money goes directly into training activities. The second step is to ensure that the training offered relates to the specific needs of specific employers."

He goes on: "The basic responsibility . . . must reside with employers, who know best their own training needs and most often are best prepared to provided them."

Representative Miller's bill of the last Congress, H.R. 5820, addressed the challenge from the demand side, and the Association of Community College Trustees provided written comments to your California hearings supporting his concept. If industry is given incentives to offer the first piece of the training dollar, then taxpayers will have stronger assurances that displaced workers and the unemployed are being trained for real jobs.

In your December mark-up of H.R. 7130, Mr. Chairman, you voiced alarm that the National Science Foundation was not responsive to initiatives in community colleges and smaller universities, and that it had done little to advance the development of technician training. We echo that concern. NSF can and should do much more to expand the nation's techician skill base. Just as the United States' competitive advantages in industry have dwindled away over time because of neglect of the skill base, any edge we may still enjoy in technological and scientific discovery also will be lost over time, unless we rebuild that skill base.

In revitalizing the science and math programs at every level of education, the community colleges already are a stong partner, and a natural partner. Vast amounts of applied math and applied science are being generously imparted to millions of adult students through the technician courses that range from the health sciences to management systems.

These facts surely contributed to General Motors' decision to disperse its technician training into a community college network that eventually will span more than 60 colleges scattered throughout the country and to the partnerships on training which the United Auto Workers and the major auto makers are building with community colleges. A National Center for this program is now being erected on the Henry Ford Community College campus. These are not isolated initiatives. They are prime examples of the working partnerships that the community and technical colleges are building with the industries they serve. Such initiatives are spurs to math and science education both directly and indirectly.

Community colleges have been moving ahead on their own, as a matter of necessity, to beef up their math and science programs. As they respond to exploding technology and open more and more technician courses, they find it imperative to offer better and better math and science instruction.

Many face a demand for computer training that they cannot always serve. In computer science and in many other new technologies, the community colleges use adjunct instructors from industry to give courses.

Rend Lake College in Ina, Illinois, for example, has registered 30 percent increases in science and math courses in just the last two years. Harry Bruan, President of Rend Lake College, offers these observations:

"These increases have been attributed to several reasons including the requirement for students planning to transfer to four-year institutions being computer literate, the increased general interest in computer science, science and math, and the need for math and computer literacy in vocational-technical programs.

"The college has been requested and has provided computer education for area elementary and secondary teachers. In addition we will soon be involved in training 100 teacher aides for special education. Many of the specialized techniques in this training will involve computer related instruction."

As President Braun illustrates, community colleges are reaching out to their local school districts to provide assistance in improving math and science instruction. Next door to our Nation's capital, Northern Virginia Community College is cooperating with both the local schools and George Mason University to provide advanced courses for the math and science teachers in the school system.

Similarly, at Kern Community College District in Bakersfield, California, a number of the Physical Science faculty spend one afternoon per week at local high schools to counsel students about science programs. And the Kern faculty also help to instruct the advanced math classes in at least two high schools. To give the Committee a sense of lenghts to which community colleges are extending themselves to help meet this challenge, I would like to offer for the record a letter from the Chairman of the Physical Science Department at Bakersfield, Dr. Robert Allison, detailing the variety of their initiatives.

North Carolina is at the point where 21 percent of the high school diplomas, or their equivalent, are being awarded through the State's community and technical colleges, which have become by the Governor's decree the "presumptive" delivery system for all the adult employment training.

As we view H.R. 30 itself, Mr. Chairman, your support for fellowships that foster teaching careers in math and science is most commendable.

The more pressing needs of community colleges are concentrated largely in two areas—equipment and professinal development. And these are not mutually exclusive needs. The colleges that are heavily programmed toward "high tech" fields almost all have dire needs for state-of-the-art equipment in some or all of their tech and science courses. They also need assistance in professional development which would help them two ways—encourage their instructors in math, science and tech fields to stay with their teaching careers, and at the same time provide honing for their skills on state-of-the-art equipment by working in industry.

Thus, we also applaud your program offering matching grants to help colleges acquire state-of-the-art equipment. We urge that you consider funding this program at $200 million.

It is also our earnest hope, Mr. Chairman, that you and this Committee can work with the Ways and Means Committee to legislate tax benefits to industry that would encourage companies to help education on three fronts:

1. Expanding their gifts of state-of-the-art equipment for use in occupational programs.
2. Allowing professional personnel released time, on a systematic basis, to serve as adjunct faculty in math, science and "high tech" courses.
3. Providing summer or off-term employment for math, science and "high tech" instructors, so that they stay with their teaching careers while they also stay versed in the state-of-the-art through such employment.

If you wish further comment on H.R. 30, we would gladly respond. We thank you again for this opportunity.

BAKERSFIELD COLLEGE,
Bakersfield, Calif., January 24, 1983.

Mr. FRANK MENSEL,
Vice President/Director of Federal Relations, AACJC/ACCT, One Dupont Circle NW., Washington, D.C.

DEAR MR. MENSEL: Dr. Jim Young asked me to write to you regarding the science, mathematics, and technology programs at Bakersfield College and the possible impact of future federal funding programs for science education on them. I will describe some of our current efforts, how we should be responding to current and future technological changes, and how the federal government can and should be helping us.

Because the time available for the preparation of this letter was very limited, it should not be assumed that it is a comprehensive description of either our science and mathematics activities nor our needs in those areas. Rather, it should be considered a representative sampling of those activities and needs.

USE OF LOCAL FUNDING IN SCIENCE/MATHEMATICS EDUCATION

The following are some of the ways in which the District has committed its own resources to science/mathematics needs in recent years.

1. In 1976 the District made a commitment to instructional computing by purchasing a computer and associated equipment for Bakersfield College. This computer was—and is—intended for instructional use only. Including its purchase price, more than $800,000 in local funds have been used since then for futher equipment, supplies, maintenance, and personnel costs. Currently the computer is used for instruction in data processing, computer science and in computer assisted instruction. Approximately 2500 students use it regularly as part of their instructional activities, and a large proportion of these are science/mathematics majors.

Since 1976 we have received three National Science Foundation grants, all intended to promote the use of the computer in science instruction. One grant allowed us to develop instructional software for use in physical science and engineering courses and to purchase equipment, the second provided funds for equipment only, and the third was for a summer training program in computer assisted instructional techniques for community college instructors. The latter, operated in cooperation with the League for Innovation in the Community College, included participants from all over the United States. All of the grants required local contributions, totalling about $180,000. These grants had a profound effect on our ability to offer up-to-date instruction in science/mathematics and computer science.

The increased instructional computing activity and capacity resulting from those grants had the additional effect of interesting a large number of additional science (and non-science) faculty in computer use. As a result, the College has funded two inservice workshops on computer assisted instruction in the past year. Instructional computing is now to be found in such areas as English and political science as well as the sciences.

2. In Spring 1982, the District Board of Trustees approved spending $75,000 from the District reserve funds to partially ameliorate the critical equipment problems in the Life and Physical Science Departments. These funds were used to replace worn out and/or obsolete equipment. The situation requiring this special appropriation arose because inadequate state and local funding, especially since the passage of Proposition 13 in 1978, had forced the elimination of most equipment requests from our budgets.

3. Even with budget restrictions, the College and the District have provided continuing support for quality programs in science/mathematics. Our engineering program, for example, is one of the best to be found in any community college. One of the very few positions authorized for filling in the past year was that of a new engineering instructor.

4. At Bakersfield College, the Professional and Organizational Development Grant program has provided expenses and stipends for faculty who wish to develop new courses and/or programs. One outstanding outcome of this is the Nature Study and Science Program, a series of short courses designed for the needs of elementary school teachers. It has been very successful and is one of the ways in which Bakersfield College is attempting to improve the level of science education in its community.

SCIENCE EDUCATION NEEDS BEYOND LOCAL FUNDING CAPACITY

Below I will list some of the areas in which outside funding will be required if we are to continue to meet the demands of current and future technology.

1. Three of the disciplines included in my department are architecture, engineering, and industrial drawing. All of these areas involve drafting, and the technology of drafting is in the process of radical change. It has been estimated that within the next few years, virtually all drafting will be done using computer assisted drafting/design CAD. In order to find out how we should be responding to this, recently we conducted two surveys. In the first, we asked all California community colleges to describe their CAD curriculums, if any, and their plans in that area. In the secoand, we asked 76 local firms about their current and future use of CAD. The results of both indicated that we should have a CAD program in operation at Bakersfield Col-

lege within the near future. In order to accomplish this, however, $75,000 to $100,000 will be needed initially for the instructional equipment.

2. The instructional computer has grown in use and amount of associated equiment, but the demands on it continue to increase. Some of the current needs include: terminals for the life sciences laboratories, current language compilers in FORTRAN, Pascal, and RPG, communication equipment to better serve remote terminal areas and increase capacity, projection terminals for instruction in computer science, plotters, and a new line printer.

3. In the past, the National Science Foundation funded workshops, continuing education institutes, and academic year fellowships for college teachers. I am the graduate of three of these, and I found them to be some of my most valuable educational experiences. In fact, my education in computer science began at an NSF institute in 1967. My involvement in computer assisted instruction activities and the fact that I now teach computer science is directly attributable to that 1967 experience. The CAI workshop referred to above, of which I was the project director produced, in turn, thirty enthusiastic faculty users of CAI. As technology changes, even more faculty will be in need of the kind of updating provided by these programs. For some faculty, the need is for retraining, not simply updating, as the requirements of our students change. For example, the need for more computer science faculty is growing while the enrollments in some areas are decreasing. Thus, a federal program of such updating/retraining programs would be very beneficial.

4. As mentioned above, the funds available for science equipment purchases, even for replacement of worn out or obsolete items, are very limited. In the past, NSF science equipment grant programs recognized the importance of good equipment in science instruction. Those programs, now discontinued, will inevitably cause us to fall behind as technology advances. Although the special grant received from the District last year helped considerably, significant needs still exist. These include equipment for instruction in computer science, electronics for engineers, anatomy and physiology laboratory equipment, chemical instrumentation, engineering test equipment, and, as mentioned above, computer assisted drafting/design stations.

To summarize, then, our needs, as I see them, are in three categories: equipment for new programs (e.g., CAD), updating/replacing equipment for existing programs, and faculty updating/retraining.

TECHNOLOGY TRAINING FOR COMMUNITY NEEDS

Most of our science students intend to transfer to a four-year university and obtain a bachelor's degree. But some programs are for those intended to attend for two years or less and then enter the job market, usually locally. We have a large number of technologically oriented programs for these students, six examples of which are listed below.

1. Geologic technology.—Training in geology and related subjects for employment in the oil industry (primarily) as geological or engineering assistants.

2. Industrial/architectural drawing.—Employment in a large variety of local businesses, including oil and engineering.

3. Solar technology.—Training of installers and contractors in principles and applications, including design and installation, of active and passive solar equipment.

4. Machine technology.—This is beginning to include training in computer assisted manufacturing (CAM). The equipment currently available for use in CAM instruction includes two computer-controlled machine tools and a microcomputer.

5. Petroleum technology.—This is not a single program but includes a variety of courses designed to meet the special needs of various segments of the petroleum industry. All of the courses are taught by outside instructors recruited from the industry. Bakersfield College now has an oil rig on campus donated by the industry for instruction in the Floorman Training (roughneck) School. This is a four-week school totally funded by the industry. Graduation from the school is a very important factor in obtaining oilfield jobs in this area.

6. Data processing—This program trains people for positions as programmer trainees—junior programmers or computer operators.

These programs represent some of our efforts to serve the technological needs of the community. All of these require highly specialized knowledge and equipment, and all of them are expensive. To be useful, the equipment must be similar to that actually used in industry. Currently an effort is being made to upgrade our instructional equipment. So far, equipment donations from corporations and some grants have been received. At this time, the most immediate equipment needs for these programs are a computer controlled machining center, an industrial robot, and computer and telecommunications equipment.

COOPERATIVE ACTIVITIES WITH FEEDER SCHOOLS

Bakersfield College is engaged in a number of activities involving the K-12 grades in the schools of our service area. Some of these are listed below.

1. A regular program of vistitations to local high schools is designed to acquaint students and teachers with the programs available at Bakersfield College. These often involve discussions about curriculum and articulation.

2. The Nature Study and Science series mentioned above has resulted in a greater awareness of the importance of science education in the elementary grades and is resuting in an improvement in the quality of science teaching in those grades.

3. The Physical science Department operates a planetarium program which is extremely popular with K-12 students.

4. Our science and technology instructors have served as consultants to the local schools in the areas of articulation and curriculum. One of our chemistry instructors became, in effect, the science curriculum consultant for a small school district nearby. Our instructors regularly serve as judges in science fairs and similar events.

5. The Life Science Department has aided the schools by donating or exchanging live specimens used in school laboratories.

6. The Industrial Education Department regularly invites high school teachers to visit and to discuss curriculums.

7. One member of the Physical Science Department spends one afternoon per week at a local high school to provide information to students about our science and other programs.

8. The new engineering instructor referred to above has been regularly visiting high schools to explain to science classes what engineering is, what engineers do, and how they should be preparing themselves if they want to major in engineering.

9. We are in frequent communication with the local science curriculum coordinator for K-12 and will be hosting the February meeting of Kern Science Educators Association. One of our physical science faculty will be the featured speaker at that meeting.

10. Next month the college will be hosting a workshop for junior high school girls on the subject of women in science. The purpose of the workshop is to interest these girls in pursuing science/mathematics careers. This was arranged by one or our mathematics instructors.

11. A workshop in instructional computing for high school teachers this Spring and one for K-12 this summer most likely will be presented by college faculty.

12. The director of the College Instructional Computer Center is very much a part of the local program to bring instructional computing to grade K-12. He has served on a number of committees, is acting as consultant, and he will be a speaker at the K-12 Computer Fair to be held next month.

Probably the most important factor impeding more involvement with our feeder schools is lack of adequate staff time. If funding were available, released time could be granted for the purpose of helping the schools improve their science and technology programs. Currently, individual staff members working on their own time account for most of what is being done.

I hope this material will be useful in your testimony before the House Committee on Education and Labor. Please feel free to telephone me if you have any questions. My number is (805) 395-4224.

Very truly yours,

DR. ROBERT D. ALLISON,
Chairman, Physical Science Department.

PUTTING AMERICA BACK TO WORK BRIEF

American Association of Community and Junior Colleges/Association of Community College Trustees

Toward a Comprehensive National Policy on Human Resources Development: Projects and Initiatives

KELLOGG LEADERSHIP INITIATIVE

Purpose: To undertake a major corporate "friend-raising" and networking project by informing business/industry executives about community college capabilities for employee training, and to facilitate business-labor-college partnerships.

Highlights: A national resource network of public/private organizations involved in economic and human resource development is being established, effective models of partnerships identified, and guides for forming such partnerships developed. This project is supported by a W.K. Kellogg Foundation grant and directed by Nolen M. Ellison, a community college president on leave.

Nolen M. Ellison

JOB TRAINING PARTNERSHIP PROGRAM

Purpose: To enable community, technical, and junior colleges to participate in training programs for one million workers to be funded by the $3.8 billion authorized by the Job Training Partnership Act of 1982, effective October 1983.

Highlights: Laurence Lauth, a community college president on leave, will monitor U.S. Department of Labor development of the rules and regulations to implement the Act. In early spring he will conduct regional workshops to help local colleges take full advantage of this program and close the gap between job training (formerly CETA) and vocational education.

Laurence Lauth

AACJC/ACCT

Joint Commission on Federal Relations

BUSINESS-INDUSTRY COMMUNITY COLLEGE COALITION (BICCC)

Purpose: To make community college staff and trustees more proactive in working with employers to train a skilled work force.

Highlights: Working closely with the President's Task Force on Private Sector Initiatives, a national steering committee, chaired by Wilfred L. (Bud) McMahon, a Corning Glass Works vice president, is tapping senior corporate leadership to help guide colleges in their responses to emerging technology and changing skill needs of industry. High-tech skill shortages and "employer specific" college courses are being cataloged. BICCC was organized by the Association of Community College Trustees.

W.L. (Bud) McMahon

NATIONAL SMALL BUSINESS TRAINING NETWORK

Purpose: To help reduce the failure rate of small businesses through a network of community, technical, and junior colleges providing high-quality, low-cost small business management training.

Highlights: 251 colleges in 47 states are involved. In 1981, some 80,000 persons received a total of nearly one million person-hours of training; in 1982, 88,000 have been participating. NSBTN is funded by the U.S. Small Business Administration and directed by Carol Eliason. Over 96 percent of respondents in a survey reported program participants were "highly satisfied" with the quality of their training.

Carol Eliason

SECOND ANNUAL AACJC-NBJ MEDIA SYSTEMS AWARD PROGRAM

for cooperation between community, technical, junior colleges, and business-industry. (See Nov. 26 AACJC Letter for award nomination form.)

PUTTING AMERICA BACK TO WORK AACJC-ACCT INITIATIVES

THE COMMUNITY COLLEGE AND AMERICAN PRODUCTIVITY

Efforts that the American Association of Community and Junior Colleges and the Association of Community College Trustees are mounting to expand college programs that serve business, industry, and labor are mushrooming, at the national level, into several complementary initiatives. They range from the Business-Industry Community College Coalition (BICCC), spearheaded by Ron Mears, immediate past president of ACCT, with wholehearted cooperation from AACJC, to the Joint Commission on Federal Relations of the two associations, whose agenda already is taking sharp aim on "putting America back to work."

Taken together, these initiatives show the heightened awareness among community colleges of their growing importance to the national interest and a more productive economy. The thumbnail sketches on the other side of this "brief" are intended to give a clearer sense of the purpose and highlights of each initiative tied together by AACJC/ACCT cooperation.

JOINT COMMISSION ON FEDERAL RELATIONS

The Joint Commission was established in July 1982, under a formal agreement signed by ACCT and AACJC, expressly so that community, technical, and junior colleges would be seen by Congress, the federal agencies, and other national organizations as speaking with "one agenda, one voice" on national policy and legislative issues. The respective Boards of the two associations each have chosen seven of their own members and one state executive to form the 16-member Commission. ACCT and AACJC take turns each year choosing the Commission chairman. Already adopted by the Commission as major targets for the coming Congress:

1. Enlisting more sponsors for, and winning passage of, the community colleges' high-tech bill, H.R. 6960 (now in H.R. 7130)—the National High Technology Technician Training Act.
2. Lining up more sponsors for, and overcoming Pentagon resistance to, the military technician training bills, H.R. 5683 and S. 2337.
3. Increasing the funding for Pell Grants and College-Work Study programs to budget-ceiling levels.
4. Pursuing Vocational Education Act reforms that turn postsecondary programs into a major independent title, or boost the postsecondary setaside to 40 percent of overall funding.
5. Promoting more cohesive national policy on job training and human resource development under one comprehensive program.

The Commission, under trustee Chairman Judy Madonia of Illinois, has task forces at work on the VEA reauthorization, the Higher Education Act reauthorization, and a general statement of principles and goals to guide the two associations on legislative initiatives.

Another resource to both associations in the development of these initiatives is the Council for Occupational Education. COE, recognized as an affiliate council of both AACJC and ACCT, represents the gamut of community college professionals identified with occupational programs and high technology. The "Putting America Back to Work" initiatives draw liberally upon COE members for technical assistance on ways to enhance national productivity. As Vice President/Director, Frank Mensel is staff director for federal relations for both AACJC and ACCT.

AACJC PUTTING AMERICA BACK TO WORK TASK FORCE

Dramatic progress in building community college-business-labor partnerships now shows accelerating momentum. In the next two or three years, community, technical, and junior colleges have the opportunity to work through and fully establish such partnerships on a national basis in response to the need for highly skilled technicians.

The AACJC Putting America Back to Work Task Force, appointed by Dale Parnell, president, American Association of Community and Junior Colleges, last April called for formulation of the nation's first comprehensive human resource development strategy and spelled out its strong commitment to active college-business-labor partnerships in the interest of economic development.

Under Don Garrison, chairman of the Task Force, the group will continue its mission of helping to shape national policy through cooperative efforts with AACJC/ACCT organizations and initiatives, through statements and recommendations issued by the AACJC/ACCT Boards, and through cooperative contacts with other national organizations, e.g., National Governors Association, National Alliance of Business, National Association of Private Industry Councils, White House groups, and others.

Dale Parnell

Besides Garrison, president of Tri-County Technical College, South Carolina, Task Force members are: Vice Chairman and Executive Officer Nolen M. Ellison, president, Cuyahoga Community College District, Ohio; Arthur Avila, president, East Los Angeles Community College; Dwight Davis, director, North Central Technical Institute, Wisconsin; Carol Eliason, director, National Small Business Training Network; Andy Korim, dean, grants management and development, Community College of Allegheny County, Pennsylvania; Pattie Powell, trustee, Dallas County Community College District, Texas; George Rodda, trustee, Coast Community College District, California. Jim Mahoney, AACJC, is staff assistant.

Don Garrison

For information on these initiatives, write the person directly in charge of these projects here at AACJC, or write Bud McMahon at ACCT.

Chairman **Perkins**. Thank you very much for a good statement.

Our next witness is the Reverend William J. Byron, president, Catholic University of America. We are delighted to welcome you here today, and you may proceed.

STATEMENT OF REV. WILLIAM J. BYRON, PRESIDENT, CATHOLIC UNIVERSITY OF AMERICA

Reverend **Byron**. Thank you, Mr. Chairman, and members of the Committee. I would like to add also I was a one-time mathematics teacher in high school, and I also shared the Chairman's experience. I was in Germany at the end of World War II and was impressed with the ability of the young Germans to speak English and negatively impressed with the inability of young Americans to speak German.

I think the world moves on words and numbers, and if we want to be involved in moving the world and moving it toward justice and peace and a better world to live in, we have got to be really serious about preparation for the management of both words and numbers.

We have got two issues here, but I am here this morning to present to you the views of the higher education community regarding the current crisis in mathematics and science education, and I will be limiting my remarks to that. I have a statement for the record and on the face page of that statement are listed the higher education associations for which I speak today. They join me, Mr. Chairman, in commending you for the timely introduction of H.R. 30, right up front, right at the beginning, and for putting it early in the legislative agenda of this committee, because we think rapid action is needed to begin to prevent further deterioration of our scientific education system.

However, while arresting the erosion in our current system, we must also address the need to build capacities for the future. As this committee builds on the timely and the very necessary legislative initiatives contained in H.R. 30, we urge you to give consideration to the broad areas outlined in our proposal and to work cooperatively with other committees of Congress so that effective solutions to this crisis can be developed.

The purpose of my brief testimony is to share with you a paper entitled "Higher Education's Agenda in Mathematics, Science and Technology Education," and then to acquaint you with the proposals that it contains. The agenda was developed as a collaborative effort by the 18 higher education associations that have endorsed the document, and on whose behalf I am speaking today. Together, they represent the Nation's 3,000 2- and 4-year colleges and research universities. So, Mr. Chairman, I respectfully request permission to introduce that document into this record.

America's postsecondary education institutions, like their elementary and secondary education counterparts, face a unique dilemma with respect to the current crisis in our scientific education system: the Nation's colleges and universities are themselves victims of the crisis, while at the same time they hold major promise for its solution.

One thing that delights us about H.R. 30 is that it is a piece of legislation that covers the whole spectrum, elementary, secondary, and higher education.

We believe that higher education's problems must be addressed to enable its resources to be directed toward the most critical problems that beset the science education system—training adequate numbers of qualified mathematics and science school teachers; providing education for science and technology related careers; encouraging the proper research environment, experience and tools to train the next generation of scientists, engineers, and researchers; and finally, the final part of that challenge, conducting research to improve instruction and the educational uses of information technology.

Our paper, which will be part of the record, "Higher Education's Agenda in Mathematics, Science and Technology Education" suggests a comprehensive set of proposals designed to assist colleges and universities realize their potential for helping to solve the Nation's science, mathematics and technology education crisis.

In addressing the broad dimensions of the problems, the agenda incorporates the view of the higher education community that both the Department of Education and the National Science Foundation, which has been mentioned several times in the earlier conversations today, that both of those entities have important roles to play in supporting a revitalized Federal commitment to science education. Therefore, the agenda proposes the establishment of five new programs, two to be administered by the Department of Education, and three by the National Science Foundation. We believe that each program is an essential component of the total effort needed in this area.

I will just describe with a line or two each of those programs and that will be the conclusion of my testimony.

For the Department of Education, we propose a grant program for schools, colleges, and universities to encourage the linkage between colleges and universities on the one hand, and public and private elementary and secondary schools on the other, a linkage in the improvement of science education. We want teacher training initiatives.

Next, we also propose, within the Department of Education, a new program, administered by the National Institute of Education, to strengthen research in both teaching and learning, and to do that through grants focused on the identification of successful instruction and the application of cognitive research to improved instructional programs. We are interested, in other words, in educational research in the very problem areas that are creating the crisis this legislation is trying to deal with.

Third, for the National Science Foundation, we would propose the establishment of a series of new and expanded programs to provide fellowships, traineeships, summer study support, research incentive awards, and faculty renewal awards to increase the production of scientists, engineering faculty, researchers, and science educators, and to upgrade teaching faculty. We want to produce more scientists and engineers, and we think NSF should be asked to help toward that end.

We also propose for NSF a new program to improve undergraduate instructional programs and to develop school and college materials for mathematics, science, and technology education.

Finally, at NSF, we propose a two-part program for the acquisition and installation of modern instructional equipment for use in teaching and training for teaching; and for sharing scientific equipment among institutions regionally and between the academic and business sectors. Of course, we stand ready to assist the committee in any way we can to bring these goals toward realization.

If I were to summarize my personal feeling here, I think the emphasis should be on the development of quality teachers at all levels. There simply has to be the ability to communicate that enthusiasm for scientific and mathematical learning. That is not going to happen unless we have quality people doing the communication.

To go back to what I said at the beginning, words and numbers move the world, words in a variety of languages, not just our native tongue, and numbers as expressed in mathematics and on through the implications of science. We simply have to address ourselves to the basic problem of heightening this Nation's ability to manage and understand words and numbers. If not, we will just fall behind.

Thank you, Mr. Chairman. I will be happy to take any questions.

[The statement of Reverend Byron, with attachment, follows:]

HIGHER EDUCATION'S AGENDA IN MATHEMATICS, SCIENCE AND TECHNOLOGY EDUCATION

BACKGROUND

America's productivity, economic welfare and national defense are threatened by the growing crisis in our education system. Awareness of this problem manifested itself during the 97th Congress in numerous legislative proposals, reports of the National Science Board Commission on Precollege Education in Mathematics, Science and Technology, the proliferation of private sector programs, and widespred media attention.

The dimensions of the problem are multifaceted and permeate our educational system from the precollege level to the community college, the undergraduate classrooms and the graduate universities. There is considerable evidence of the decline of our scientific educational system:

Documented declines in student achievement in mathematics and sciences. Average science and mathematics scores on standardized college entrance tests have been dropping steadily for 20 years;

A serious shortage of qualified mathematics and science teachers. During the 1970's the number of secondary school mathematics teachers being trained declined 77 percent; science teachers being trained declined 65 percent. Some 50 percent of newly employed teachers nationwide are currently uncertified and unqualified to teach mathematics and science. This situation is exacerbated by the rapid departure of trained classroom teachers for better paying jobs in industry;

At least 2,000 vacant faculty positions in university engineering departments. These vacancies have resulted in enrollement limits which, in turn, impede the training of adequate numbers of B.S. engineers;

The obsolescence of much of the instrumentation and equipment used in college and university laboratories has been well documented;

Tens of thousands of technician openings are going begging even as the national rate of unemployment approaches 11 percent. The Congressional Budget Office projects that new technologies will make 3 million more jobs obsolete by the end of this century;

Secondary students are taking fewer courses in math and science than in years past, and fewer courses are being offered. Half of all U.S. high school students take no mathematics after the tenth grade, while in other industrialized nations, particularly Japan and Germany, increasing emphasis is being placed on science and mathematics education;

Since 1972 there has been a 54 percent decline in the number of Ph. D's awarded in engineering yearly to U.S. nationals, while Ph. D's in engineering awarded to foreign students have more than doubled; and

Japan, one of our primary competitors in the world marketplace, produces twice as many engineers as we do even though their population base is half ours. From 1970 to 1977 the number of engineers per 1,000 workers increased by 48 percent in Japan and decreased by 9 percent in the United States.

There is bipartisan recognition of this growing crisis. President Reagan, in a message to the 1982 National Academy of Sciences Convocation on Science and Mathematics in the Schools, declared: "The problems today in elementary and secondary school science and mathematics education are serious—serious enough to compromise America's future ability to develop and advance our traditional industrial base to compete in international marketplaces." The Special Task Force on Long Term Economic Policy of the House Democratic Caucus observed in its report Rebuilding the Road to Opportunity: "In the future, a well-educated, well-trained workforce will be essential to sustained economic growth . . . The future will be won with brainpower . . . The research we must undertake to produce new technologies requires talent—yet we are not graduating sufficient numbers of scientists, engineers and technicians."

THE FEDERAL ROLE

Although there is now general agreement on the dimensions of the problem, there is no consensus of the solution. The higher education community views the current crisis with alarm. Constructive actions at the institutional, local, state, and national levels are necessary to forestall a further deterioration.

We believe the federal government must play a central role in providing leadership and support for a variety of initiatives outlined in the following pages. Sustained federal investment is required because the problems are national in scope and because failure to resolve them would have grave implications for our national well-being and defense capability. These investments will maximize the return on scarce federal resources, encourage local and individual initiatives, minimize federal control of these efforts, and provide incentives for collaboration among all sectors.

America's postsecondary institutions—two-year, four-year, and graduate—all have a major role to play in restoring our economic health and bolstering our national defense. There resources should be directed to the most critical problems that beset the science education system so that adequate numbers of qualified mathematics and science school teachers will be trained; education for technology and science-related careers will be provided; the proper research environment, experience and tools to train the next generation of scientists, engineers and researchers will be encouraged; and research to improve instruction and the educational uses of information technology will be supported. With such steps students will be sufficiently science-literate to live in an increasingly technological world and have the opportunity to prepare for careers in the sciences; and currently employed teachers, engineers, scientists and researchers will have opportunities to upgrade their skills.

Thus we urge the 98th Congress to enact major legislation that will enable colleges and universities to further fulfill their mission as a vital force in solving the current science, mathematics, and technology education crisis. The higher education community recognizes the interrelationship among all levels of education in resolving the crisis and supports the efforts of the precollege sector to solve their own unique and compelling problems. However, this paper attempts only to address the crisis from the perspectives of higher education.

PROPOSED FEDERAL PROGRAM

The higher education community—collectively listed at the end of this paper—supports the establisment of five new programs to be administered by the Department of Education and the National Science Foundation. These programs represent the top priorities of the higher education community regarding science, mathematics and technology education. Each is an essential component of the total effort needed in this area.

For the Department of Education, we propose two programs: a $200 million program for teacher training initiatives to improve science, mathematics and technology education, and a $25 million program to strengthen educational research in these areas.

For the National Science Foundation, we propose three programs: a $100 million program providing opportunities for teachers, young scholars and researchers through expanded graduate fellowships, new traineeships and faculty research awards; a $50 million program to upgrade and improve instructional programs on all levels; and a $200 million program to upgrade instructional equipment and its utilization.

The total $575 million dollar federal investment proposed provides a significant number and variety of new awards to individuals, schools, and colleges. Coupled with local, state and private sector initiatives, these programs will make a substantial contribution toward the revitalization of the science education in the nation.

In embarking on this new federal effort in sciences, math and technology eduction we must acknowledge the importance of a sustained national commitment to basic research. Without quality research programs, the education enterprise will wither. Our proposal for new federal support of science educattion should be viewed as an integral part of this commitment. Both research and education are necessary for the economic vitality and defense strength of the U.S. Neither should be funded at the expense of the other.

Title: A program for teacher training initiatives to improve science, mathematics, and technology education

Agency: Department of Education

Authorization: $200 million.

Target: 3,000 grants at up to $200,000 each to schools and colleges.

We propose the establishment of a grant program for schools, colleges and universities to be administered by the Department of Education with proposals to be evaluated through a peer review process involving consultation with NSF to identify field readers. The purpose of these grants is to encourage the linkage between colleges and universities and public and private elementary and secondary schools in the improvement of science education. Grants would allow maximum institutional flexibility to be responsive to local needs, and would be awarded according to plans developed by the recipient institution in collaboration with one or more public or private schools or school districts and other appropriate agencies or councils. Priority activities might include, for example:

(1) Summer institutes and workshops and a parallel program of inservice education, conducted by higher education institutions across all states and regions to provide practicing teachers and supervisors with up-to-date science and mathematics information and pedagogical concepts;

(2) Projects to enhance the capacity of schools and colleges to meet the professional needs of both new and practicing teachers, including faculty development activities; and

(3) Support for exemplary state, local and institutional efforts to attract, retain and motivate teacher's to pursue careers in precollege mathematics and science education, as well as identification of teacher training projects providing nationally significant examples of campus-based inservice, school site staff development, and the integration of substantive knowledge in mathematics and the sciences with effective teaching strategies, and the dissemination of information about these programs.

Title: A program to strengthen educational research in mathematics/science and technology education

Agency: National Institute of Education, in consultation with the National Science Foundation.

Authorization: $25 million.

Target: New grant competitions for specific research yielding 10 major programmatic awards, and up to 200 individual research grants.

Research on student learning and school and college instruction in math, science, and technology education (particularly focused on secondary schools) is an essential resource for other federal, state and local programs for improving math and science education.

We propose a new program to strengthen teaching and learning research through grants focused on the identification of successful instruction and the application of cognitive research to improved instructional programs. The program will support a large scale research competitions dealing with:

(1) Research on thinking, teaching and learning related to instruction in math, science and technology;

(2) Research on the uses of modern instructional technologies; the status, means of assessment, and selection of instructional software and other mathematics, science and technology education materials;

(3) Research on local, state and institutional policies enhancing or inhibiting the recruitment, retention and professional development of school and college math and science faculties; and

(4) Research on school, institution and state needs and operations as they relate to the development and support of remedial programs at all levels of education.

Title: A program of opportunities for teachers, young scholars, and researchers through expanded fellowships, new traineeships, research incentive awards, and faculty awards for summer study

Agency: National Science Foundation.

Authorization: $100 million.

Target: $15 million to expand existing graduate fellowships and to create 600 new graduate fellowships; $15 million for new institutional traineeship programs; $50 million for 1,000 new faculty research incentive awards; $20 million for faculty awards for summer study sabbaticals and special research opportunities.

We propose the establishment of a series of new and expanded programs to provide fellowhips, traineeships, summer study support, research incentive awards, and faculty renewal awards to increase the production of scientists, engineering faculty, researchers and science educators, and to upgrade teaching faculty.

Four programs should be supported in this area:

(1) An expanded Graduate Fellowship Program. The structure and effectiveness of the NSF Graduate Fellowship Program, once a premier symbol of the nation's commitment to excellence, has diminished steadily over the years. The NSF fellowship program should be expanded by increasing the number of awards and the amount of the stipend. To achieve this, we propose at least doubling the amount of money available for these fellowships (from $15 million to $30 million) and increasing by approximately one-third both the number and size of the current awards (from 1,400 to 2,000 and at least $15,000 rather than $10,900 per award).

(2) A new $15 million Traineeship Program for science, technology and mathematics educators. Awards of up to $150,000 would be made to colleges and universities. Trainees would be selected by participating departments, schools and institutions from among individuals with demonstrated potential to excel as science, technology and mathematics educators at elementary/secondary and undergraduate levels. Institutions receiving traineeships would gather education specialists and faculty from departments of science, mathematics and technology to create for the trainee a new or improved quality program for preparing the next generation of science educators.

(3) A new $50 million Young Faculty Research Incentive Awards Program. The challenges facing young faculty who seek to establish their first research programs are almost overwhelming. A program offering stable support (averaging $50,000 per year per award) to assist them in starting academic research careers would help to sustain the quality and flow of individuals into key fields of science, mathematics, engineering and technology. 1,000 awards would be authorized to average $50,000 per year.

(4) A new $20 million program of Faculty Awards for summer study, sabbaticals, and special research opportunities. This program would provide 3,000 awards at $5,000 each for summer support to permit currently employed faculty to take advantage of upgrading opportunities; and a $5 million program for experienced faculty for six- to twelve-month periods at salary equivalent to current levels to: (a) permit revitalization, and experience with new research techniques and advanced research discoveries for those who have been isolated from research institutions and centers for six or more years; and (b) provide for intensive development of teaching techniques and materials in problem areas. A total of $20 million authorized in this area will provide awards on a competitive basis to individuals whose institutions certify that the applicant's principal function is undergraduate teaching in a science-related discipline.

Title: A program to upgrade and improve instructional programs in mathematics, science and technology at all levels

Agency: National Science Foundation.

Authorization: $50 million.

Target: 1,000 instructional improvement projects at up to $200,000 each.

Continuing demands are placed on science educators to keep pace with evolving technological innovations. Updated instructional materials are needed to enhance student motivation and to advance the lagging state of science learning. The need for new instructional materials is particularly acute at the undergraduate level for both general students and science and engineering majors.

353

We propose a new program to improve undergraduate instructional programs and develop school and college materials for mathematics, science and technology education.

Priority areas include:

(1) Restructuring subject matter science courses to reflect state-of-the-art technology and the changing needs of undergraduates;

(2) Applying teaching and learning research concepts to the development of mathematics, science and technology instructional materials for schools and colleges; and

(3) Stimulating collaborative educational institution/industry efforts in the development of improved programs for schools and colleges.

Title: A program to upgrade undergraduate instructional equipment and its utilization

Agency: National Science Foundation.
Authorization: $200 million.
Target: Grants to colleges and universities.

The outmoded condition of the instructional equipment in the nation's colleges and universities is well-documented. The absence of state-of-the-art equipment and facilities has immediate consequences in the preparation of today's students, and farreaching implications for the nation's ability to remain scientifically and technologically competitive.

We propose a two-part program for: (1) acquisition and installation of modern instructional equipment for use in teaching and training for teaching; and (2) sharing science equipment among institutions regionally and between the academic and business sectors.

We further suggest that a balanced program is needed involving all federal agencies that support research and related education programs to make the acquisition of equipment and renovation of laboratories an allowable component of research proposals.

N.B.: Existing laws and recent legislative proposals have attempted to utilize the mechanism of tax incentives to encourage a corporate response to the science education crisis. We regard these proposals as one aspect of the total effort needed to resolve the urgent problems faced by higher education institutions. These proposals are uniquely well-suited to bringing private sector resources into play. Since this paper addresses only the necessary role of the federal government in the direct provision of support, we have omitted references to these tax incentive proposals.

This proposal is submitted on behalf of the following organizations:

American Association of Colleges for Teacher Education.
American Association of Community and Junior Colleges.
American Association of State Colleges and Universities.
American Council on Education.
American Educational Research Association.
Association of Affiliated College and University Offices.
Association of American Colleges.
Association of American Universities.
Association of Catholic Colleges and Universities.
Association of Jesuit Colleges and Universities.
Association of Urban Universities.
California State University.
Council of Graduate Schools in the United States.
Council of Independent Colleges.
National Association for Equal Opportunity in Higher Education.
National Association of College and University Business Officers.
National Association of Independent Colleges and Universities.
National Association of Schools and Colleges of the United Methodist Church.
National Association of State Universities and Land-Grant Colleges.
State University of New York.

Chairman PERKINS. Let me ask all of you one question.

The bill authorizes $300 million for all levels of education—elementary, secondary, and postsecondary. The funds are limited to improving math and science education. But do you believe that with this—I will say a meager—beginning, we should look forward in the future to greater funding, so we can train more math and science teachers? I think we can pretty well hold with $300 million, which is, to my way of thinking, very limited.

Just how do you gentlemen feel? Let me commence with you, Reverend. What is your opinion about the funding?

Reverend **Byron**. I certainly agree with you, that it is limited, that much more is needed to match the need and the dimensions of the problem.

In the face of limited resources, my inclination would be to put the emphasis on the development of the persons who are going to be communicating in the classrooms. We simply have to attract and retain quality people in classrooms at all levels in science and mathematical education. Money will help in that total task of the attraction, the training and the retention. We have got to create a good environment for them.

I think it is the love of teaching that is going to keep people in the classroom against moving off to higher paying opportunities and industry. A better environment within which teaching can happen is going to at least assist those who really do love teaching and want to stay in that profession.

I really think the most important thing going on in the United States at this hour is what is going on in classrooms across the country, and it is going on mostly by people who are not well known and almost universally by people who are not well compensated.

Chairman **Perkins**. Thank you.

Dr. Ikenberry?

Dr. **Ikenberry**. I think you are quite correct, Mr. Chairman, when you imply that the amount of money that is likely to be able to be devoted to this legislation this year and perhaps in the immediate years to follow may be quite limited and, in a certain sense, totally unequal to the magnitude of the task at hand.

I think it is important, however, for a first step to be taken. I think it is important, both practically and symbolically. I would hope it would provide, and I would hope the legislation could be reviewed, with the hope that it would stimulate a comparable investment by State and local governments, by our own universities, public and private, by business and industry, and perhaps the collective magnitude of that investment would, over time, have some direct impact on the problem.

I would associate myself with the earlier remarks in terms of focusing limited resources on the teacher and the materials of the teacher, but I would also hope that some fraction of our resources, even——

Chairman **Perkins**. On that point, let me interrupt you.

We discussed matching funds, and perhaps the administration's bill will provide for matching. But are there other ways to develop interest from the local level, to get business and other people to contribute without requiring matching? What is the best way to do it, with your experience and background?

Dr. **Ikenberry**. One possibility, Mr. Chairman, might be to require, ask, encourage States, as they submit their proposals for these funds, to outline not just their request to the Federal Government but to outline also the steps that they are taking independently and such support as they believe they either can develop or already have developed from private industry to devote to this problem.

I believe there is a very substantial concern within the private sector to improve the quality of science and mathematics education, and I believe it is a concern that is shared by the public leaders at the State level and certainly our colleagues at the elementary and secondary level. I don't think the Federal Government can do the whole job, and I think the spirit of the legislation, whether it technically requires matching or not, can at least set forth the clear expectation that the Federal Government cannot do the total job and it is going to require a more concerted attack.

Mr. SIMON. Would the chairman yield?

Chairman PERKINS. Go ahead.

Mr. SIMON. I am concerned on this specific area, because I think this is going to be one of the areas where we may have some disputes. I think we ought to encourage the States, the State of Illinois, and the private sector, to come up with the money that they need. My concern is that the very areas that need it the most are going to be the very areas that cannot match, and that is true for States, even if I may say the State of Illinois. We have the resources. Whether we have the will to do it, I don't know.

The same in the private sector. You have some areas that really need help. If I may be a little provincial here now, coal, for example. Coal is down. We need much more work in this field. Coal ought to be moving ahead. But the coal industry probably isn't going to come up with any kind of matching funds because they're in a real struggle.

I guess I'm really not addressing this to the witnesses but more to my colleagues. I think we have to be very, very careful in that we want to encourage the States, we want to encourage the local governments, we want to encourage the private sector, but let's not end up concentrating our resources in the already well-to-do areas, and not the areas that need the help the most.

I don't know if you care to respond, and I thank the chairman for yielding.

Chairman PERKINS. Are you through, Doctor?

Mr. SIMON. He didn't get a chance, Mr. Chairman. I don't want to be putting words in his mouth and he may want to respond.

Dr. IKENBERRY. I didn't come prepared to advocate a matching requirement for this program, and I don't think any of us are testifying to that effect.

I would not, however, minimize the symbolic impact of this legislation and the potential for this legislation to stimulate the commitment on the part of State governments and local school systems and the private sector, nor would I minimize the possibility that out of an imaginative national effort will come new, different, fresh approaches to the problem of teaching science and mathematics in the Nation's schools that will many times over be greater than the amount of $300 million that will be invested in this legislation—or whatever that final figure might turn out to be.

Mr. SIMON. Thank you, Mr. Chairman.

Chairman PERKINS. Go ahead, Dr. Ellison.

Dr. ELLISON. Mr. Chairman and members of the committee, my response could really rest on the comments already made. The amount of money in the entire bill, and certainly that portion in part B right now, is inadequate to do what we know needs to be done in our great Nation today. I think there are some shortrun initiatives and incentives that are going to have to be put in place, and they are in place now in many instances. My comments again with respect to the re-definition of teachers of science and math in the short run is something that we have investigated in our own institution. We have gone to NASA. We have gone to TRW. We have gone to some of the research operations in the private sector. We brought back to our institution part-time instructors who had left formal education and the formal classroom, and many of those people are good and excellent instructors. In fact, we are using them now to fill some of the shortages and gaps that we have.

That is a stopgap measure to get us where we really want to be. What we want to be in the long term is an adequate supply of good teachers who will want to teach in elementary and secondary classrooms, who will be committed to the technological programs that bridge between technical applications in factories and businesses and classroom learning.

The longrun answers in terms of improving research and science in our great research universities is clearly a key part of the equation. The point is that the dollars in the bill are probably not enough—and you have indicated that, Mr. Chairman—but it is a start in the right direction and we support that.

Chairman PERKINS. I would like to address one brief question to all of you. We all know that we have this shortage of math and science teachers, and we have got to do something about the situation. But as we develop the math teachers and science teachers, with all the shortages that have been referred to here today, you and I know that industry is going to come along and offer them greater salaries.

How are we going to keep these math and science teachers in the classroom? Go ahead and answer that question—considering the fact that all over the Nation today we have got financial problems, and States are cutting back on their educational programs and even cutting salaries in some States. Go ahead and answer that question.

Reverend BYRON. I don't think anybody goes into teaching with a monetary motive as a primary motive. I think they recognize there is a gap between other market alternatives and what they can get through a profession of teaching. The question is, how wide can that gap get and how can we prevent the gap from getting wider. I think we are at a critical point right now of that gap getting so wide that people who very much want to stay in the profession simply cannot and they move out.

Well, one way of closing that gap for some teachers would be through this summer stipend program that you suggest. Many teachers will do various things in the summer just to make money, and sometimes it is teaching in the summer when they don't really want to be teaching. What I would like to see would be available stipend money to, in effect, "bribe" them away from other occupations so that they can have renewal programs and they can have the leisure that any good teacher needs.

I think to the extent that a science teacher has better students in the classroom, then he or she is going to be more likely to want to stay in that classroom. I think a lot of the reason that teachers are leaving has to do not so much with money but to do with the fact that it is a very difficult environment within which to work. So to the extent that something like your congressional scholars program or other programs like it could attract better and better prepared youngsters into the science and mathematics classroom, it's going to be a joy to teach there and people will stay.

So I think it is wrong to look at perfect parity with the private sector. It is never going to be there. There are other advantages which are nonmonetary and we have got to heighten those and preserve those.

Chairman **Perkins**. Dr. Ikenberry.

Dr. **Ikenberry**. The question you raise could be the most central issue, or certainly one of the most central issues, in attacking this problem effectively on a national basis. I certainly don't have the answer to your question except to note that, unless some answer or some collection of answers is found to that problem, simply training more teachers will not ultimately turn out to be the answer because those individuals will simply rotate through the schools and on out into the private sector, and we will end up 5 or 10 years from now with the same problem that we have today.

I think the options that have been outlined earlier are certainly workable ones. We need to come to grips with being more market-sensitive in our compensation plans for teachers. At the higher education level, we simply have to pay engineers, for example, and computer scientists, a more competitive salary on our faculties to be able to attract and retain them. If we don't, we simply cannot employ them. So differential, market-sensitive compensation systems in our school systems I think need to be looked at more realistically and more carefully—summer institutes, part-time employment with business and industry, either on a summer or during the academic year, for not only salary supplement but for intellectual supplement.

I think that is why also I would encourage the exploration of the use of technology in teaching science and mathematics. We may be able to put, for example, a computer terminal into a school where ultimately over the long term we are simply not going to have adequate numbers of science and mathematics teachers to handle the load of instruction, and the skills of the teacher can be extended through technology.

But the question you raise is a very key question.

Dr. **Ellison**. Mr. Chairman, I would say "all of the above", plus the potential of making the learning environment, not just the classroom, a more exciting place for dedicated teachers to be.

I happen to believe that the question that President Ikenberry raised of the application of technology in the classroom, the learning laboratory really being more than that classroom as we have known it in the past, I think our ability in the education field to help faculty members to have the kind of nurtured environment. Salary and compensation as it is today is not the only issue that will keep them there. Professional development opportunities, the opportunity to have access to the kind of equipment and the kind of environment that will make, indeed, teaching remain a reinforcing, exciting adventure, as opposed to something that one might learn or begin to believe they would dread.

The application of the computer—and I go back to the PLATO experience—we have not moved fast enough in that area, so that faculty members could have opportunities to allow students to discover and learn in the most reinforced environment, which is a one-to-one environment, a self-paced kind of instruction opportunity where teachers are managing a learning environment as opposed to have to teach that environment. I think our long-term ability to reexcite the climate, which is a responsibility and a challenge that we're going to face in education, is probably one of the issues.

Reverend BYRON. May I add just one word—and this would be from the perspective of the independent, tuition-dependent institutions. Without adequate student aid, we're not going to get the tuition revenue that is going to enable us to compensate our faculty members and thus hold them in the classroom. What we are talking about today is all reinforced, if you will, by the available student aid that will enable the students to keep coming to both the public but particularly the independent institutions.

I would also like to take a moment to thank Mr. Simon for all of the effort that he put forth in the last session to protect that student aid.

Chairman PERKINS. Mr. Simon, we will start with you, and you take the chair.

Mr. SIMON [presiding]. Thank you, Mr. Chairman.

First of all, Mr. Chairman, before you leave, I was pleased to note we're going to hold at $300 million. The administration, apparently, is coming in with $50 million, and we're holding at $300 million. That is encouraging.

Chairman PERKINS. They have introduced, I think, a bill for $251 million, or agreed to that on the Senate side, and if we don't hold at 300, we'll be bad conferees.

Mr. SIMON. All right.

Let me comment also on this question you just responded to, because I think that whether it is science or math or whatever field, the whole question of quality teachers is a very fundamental question in our society. As we have problems in the elementary and secondary schools today, inevitably, just as heat rises, those problems are going to permeate the colleges and universities and I think we have to face up to those problems much more than we have.

I have already indicated I am going to be trying to amend this to include foreign languages because I am concerned not simply with the problems that the Secretary of Defense and Secretary of Commerce have called to our attention, but I am concerned that we get the scientists who can build bigger and better bombs but we have fewer and fewer people to communicate how to prevent the use of the bombs. So, we should expand the bill to include foreign language.

I still have—and I am a supporter of the bill—but I do it with some unease. I had to leave, President Ikenberry, while you were testifying to meet with some people from my district, including a first grade teacher from Mound City, Ill., in Pulaski County, with 29 percent of the population of that county on welfare today. I am concerned not only with the math and science teachers but with those first grade teachers in Mound City, Ill.

Can you address my unease on this bill in that connection? Father Byron, I will start with you, since you're a counselor here as a Jesuit.

Reverend BYRON. I share the concern. All I could say is that if we get exciting classroom teaching in elementary, secondary, or higher education in mathematics, that is going to have a tendency to spill over into other areas.

As a liberal arts dean at one time, I used to say that we had the task of not only humanizing the scientists, which we are all trying to do and continue to try to do—and I think there is a lot of evidence that we have failed in our efforts to try that—not only do we try to humanize the scientists, but we also have an obligation to scientize the humanists and to make them literate in the issues that they are going to have to reflect on philosophically or in literature or whatever else. There is a great deal of ignorance about scientific reality in our society, and that ignorance is being protected, if you will, in many humanistic quarters, simply because they have not opened themselves up.

So, although, as you know, I agree with you very much in your effort to get more language study, and in all of the efforts you have for higher education throughout, I also see a value in the emphasis that is in H.R. 30 at this time with the hope there will be a ripple effect out into other areas of education.

Mr. SIMON. Dr. Ikenberry.

Dr. IKENBERRY. I don't know that I can add much to what I think is a very thoughtful response to your question. The quality of education generally, at all levels, is a keen concern in this country, I think, a growing concern. It is the concern that you cite.

In this particular instance, it seems to me that it is justifiable to begin a first step to focus on science and mathematics, indeed in foreign languages as well, if that were the will of the Congress, to begin to target certain areas that are most severely in need, not just in our school systems but in terms of the national interest in those areas.

I believe, too, the assertion that the improvement here—improved teaching, improved quality of teachers—and increased public attention to the problems of science and mathematics, the problems of inadequate foreign language, both in the breadth of coverage and extent of study, that that will have significant spillover effects that will improve the quality of education generally.

Mr. SIMON. Thank you.

Dr. Ellison.

Dr. ELLISON. I was not as familiar with, even though I read the section A—part of the unease that I sense your comments relating to really has to do with the use of funds by local education agencies. I think we are suffering today, I think society generally is suffering, a lack of a sense of community in a lot of our efforts, a lot of a sense of pride and understanding where we're going together, not individually. I think that is probably the root of this problem of salary and compensation, even—my share.

I think the summer institute program that is in section B tied very strongly to that core of people that we have now in creative uses of section 604, which is the use of funds by local education agencies. We initiated team teaching as a way of having faculty members rekindle a sense of cooperativeness in the education enterprise, that is, in individual classrooms; we even built classrooms in the public schools where team teaching is encouraged.

I think part of your unease—and that's the only thing I can add to the comments of my two colleagues here, to build stronger bridges between teams of faculty in the areas that we are talking about, that really are reinforcing to both the work of individuals in the classroom, but also the larger sense of cooperative effort in the larger problem, whether it's in the local school district, cooperation between the local community college, the local 4-year university, the cooperation not only in the summer training sessions, because there was money available, but the real exchange that is going to have to go on between the classroom teacher and the university faculty, the real training and encouragement that is going to go on in the internships in business and industry and the optional leave program or plan that is created.

It seems to me that there will be no real magic in rekindling the spark that you're talking about, except it is going to be done with some creative approaches, it seems to me, in those two areas. It's a process question as much as it is a structural one, in the bill.

Mr. SIMON. If I may follow through—and I would appreciate all three witnesses responding to this—as I look over the bill, and we will be amending it some, or we will be having some informal discussions on where we go on amendments, the summer institute provisions that you talk about are a way of moving rapidly into the school systems to really upgrade teaching. But it depends on the higher education community providing leadership on this.

Is this something that you are—if you can just speak for your three institutions—if Federal funds are available for summer institutes, is this something your three institutions would welcome and move on and provide leadership on, or is it—well, let me just leave the question there.

Dr. ELLISON. Not only would we probably do that, Mr. Chairman, but we would probably sit down, as I indicated earlier—and you would be interested in seeing the little monograph that describes something called a "Center for Science and Technology" at a community college. We probably would sit down with Cleveland State University people first; we would probably sit down with Case Western University people first; we would probably sit with some of the NASA people that are on our faculty teaching part time; we would sit with the school people. We would try to define together what it was we could do cooperatively to reinvigorate the thought of the development process of individual faculty members, whether they are in our institution or whether they are in partnerships and relationships with the other institutions that I named.

It seems to me that your section 604, that is in part A, the use of important community resources to achieve the purposes of the act, including teaching universities, the business sector, public agencies—you list libraries and museums, but you don't list the great research laboratories of the Federal Government—Lewis NASA and Ohio, the Air Force Base, the research center at Wright-Patterson and Illinois, the great research centers there, where I believe that part of the creative spark that we're talking about ought to go beyond some of the areas that are mentioned here into partnerships where the sense of colleagueship and teamwork can be reinforced.

I would simply say that that's probably how we would do it, and not only be a creative partner in that kind of summer institute that is more than an institute.

Mr. **Simon**. That sounds great. I think you have an excellent suggestion on amending the bill, too.

President Ikenberry.

Dr. **Ikenberry**. Certainly, the University of Illinois would respond affirmatively to the summer institute program. I think I would judge correctly that the great majority of universities and colleges across the country would respond affirmatively to that.

I would hope there would also be the flexibility within the legislation for high school students to participate or be involved in the summer institute, that would be focused, albeit most directly on teachers and supervisors in the public schools, but the opportunity for high school students to spend a portion of their summer program advancing their knowledge in science and mathematics also seems to me needs to be encouraged in this country.

We launched a pilot effort on this very score last year and focused on high school students who were ready to begin their college career but who did not have the competencies in mathematics that would allow them to enter directly into calculus. We provided a two-week intensive summer program for those students and found that 80 percent of them, as a result of that instruction, could be brought up to a level of competency that would allow them to enter directly into calculus at the University of Illinois rather than to have to take a year of remedial work after coming to us.

I would simply say that I think yes, I think the higher education community would respond affirmatively to the institutes, and yet I think there is a lot of room there for creativity and experimentation to reach directly the students themselves.

Mr. **Simon**. Thank you.

Father Byron.

Reverend **Byron**. We would be delighted to participate at the Catholic University of America. As for the potential participants, the teachers, I think the record shows they are sufficiently esthetical to survive a summer in Washington, so we would be happy to host them here.

Dr. **Ellison**. Mr. Chairman, in section 604 of your bill, line—I have a preprinted copy and I'm at section B. It says, "Two or more local education agencies are authorized to combine the funds they receive under this part for jointly operated programs in carrying out the purposes of this part." It seems to me that that portion of section A, combined more appropriately with portions of section B, where there is not only the opportunity to do that but even in some of the experiments of pilots that might be implemented under this entire act, that they might be encouraged in B to create the kind of partnerships or links not only between two local education agencies but between the colleges and universities and local business and industry, in the kind of creative partnerships that we're talking about. In other words, the sections are there. It seems to me they should be more explicit in terms of the kind of creative opportunities for resource sharing—I use the term resource sharing directly, because the problem that we have is not going to be solved with more Federal dollars alone. It is going to be solved when we indeed move beyond turf and move beyond some of the more narrow constrictures that we have developed, both in education, in business, and in the government sector, to begin the real process of resource sharing and team building toward some answers that we can do, not by more money but by a different kind of dedication to an end, and sharing the resources that we have.

Mr. SIMON. Thank you.

Mr. Bartlett.

Mr. BARTLETT. Thank you, Mr. Chairman.

To pick up on a great intro into my line of questions, and questions and comments, I want to in a lot of ways think out loud with you, along the same lines that Chairman Simon was commenting on a little while ago, back on to the subject of need and targeting and to focus it into the question of matching, because one of the things that is not in this bill and I would like your comments on is any sort of matching requirements from the local governments.

My concern is that without matching, every witness here today and every witness all week long has stated, without exception, and without equivocation, that the number of dollars that could be in this bill, whether you take the House version or the Senate version or the administration version, or add them all up together, the number of Federal dollars that could conceivably be in this bill is inadequate to meet the task of setting this as a national priority. So my concern is that without matching we automatically cut or reduce the commitment as measured by dollars in half.

Going back to Dr. Ellison's precise point a moment ago, we do more than cut that commitment in half; without matching, we eliminate or we in some way leave the potential to eliminate the involvement in the community and the resources from that community. I wonder if Dr. Ellison or Dr. Ikenberry would want to elaborate as to whether that approach towards matching is one that would, in fact, leverage these Federal dollars to a greater commitment.

Dr. IKENBERRY. I guess we're paying courtesy to each other, so I will jump in here and go first.

I personally believe that the problem is of sufficient magnitude, as I stated earlier, that there is no question but that participation on the part of local educational agencies, State governments, the private sector, and business and industry and our universities and colleges, will be required. Personally—and I speak only on behalf of my own personal views now, not necessarily on behalf of the associations that we represent—my personal view is that I would have no objection to the incorporation of appropriate matching provisions within the bill. I think the problem is of sufficient magnitude that it perhaps could benefit from that.

If direct matching provisions were not incorporated, at least some competitive provision within the bill that would encourage State education and local education agencies and others that would submit proposals under the provisions of the bill to look for other sources of support in addition to the Federal support it seems to me is a positive and constructive first step.

When one looks at $300 million, in terms of the scope of American education, it really is more of a motivational device and an opportunity to get some things moving on an experimental basis than it is a national attack on this problem.

Dr. **Ellison**. I would concur with those comments.

I would add that the opportunity to leverage along those lines I think also exists with other Federal programs that currently exist. I was last before this committee to testify on TRIO programs. Upward bound, talent search, and student special services are all support systems, theoretically, to the same kind of curriculum enhancement and motivation programs that would support the student end at least of the formula that we're talking about. So I see the question of not only looking to find ways to force applicants to answer some fairly direct questions and respond to this potential of matching, but also to define and describe ways in which they have used other Federal resources that normally have operated in a vacuum in the very area that this program is designed to impact. My own statement would be that I think the committee would do well to, if not in this act as an act, but certainly the guidelines for application, to have the local people think through very clearly what the interrelationship is of this kind of program to existing programs that might be operating currently.

Revernd **Byron**. I tend to want to be careful about a matching requirement, particularly if the requirement would be made of an already financially strapped school district or local governmental jurisdiction. I say I want to be careful of that.

I think perhaps about opening up provisions for the use of community development funds under other legislation. Perhaps if this is perceived by those in charge of local governments to be a good way of developing human potential in a district, then perhaps other funds already appropriated under other titles could be used. I am not prepared at the moment to say what they might be.

I think you might rely on a demonstration effect. If something like this by virtue of a direct grant works, then perhaps the private sector could say "we would like to participate in the same kind of a thing."

Finally I would say that, to the extent that a match would be necessary, I would suggest it be used only on a second-time grant. The first time would be direct full, and if you want to come back. the following summer or subsequent times, you would have to come back with a proposal that would contain a match.

Mr. **Bartlett**. Thank you.

To follow up on that, I would suggest to the committee and to Chairman Simon, as much as to the witnesses, that perhaps the way to resolve the dilemma of some school districts and agencies in areas not having the match potentially available is that this committee could write the match in a way to include chapter 1 of education for the disadvantaged or other highly targeted Federal grants that do exist today, that poverty level schools, in the schools that don't have that tax base, do have available that Farmers Branch, Tex. for example, does not, and to include chapter 1 or other existing Federal programs as allowing for that match might be a way out of the dilemma.

I would have one shorter question, Mr. Chairman, with your permission, and that is to go back a little bit to the need, leaving aside the match question, because that is one that the committee is going to have to resolve.

Going back to the need, though, I think I heard all of you say, and the witnesses from today and the day before say also, that the need seems to be of a shortage of math and science teachers, the need of an increased national commitment. The need seems to be widespread and is not limited to whether it's a poverty area or an area of high employment or unemployment. The chart that you provided us, Dr. Ellison, seems to show a shortage, a critical shortage, in all parts of the country.

In California, for example, you show a 54-percent critical shortage of computer science teachers, and in Connecticut, Maine, Massachusetts, New Hampshire, and Rhode Island only a—I say "only" with tongue in cheek—but a lesser shortage of 45 percent, a critical shortage, and in the Texas region you have an 88-percent shortage combining critical and general shortage. So I would ask if you would concur or object as to whether the need is widespread or if somehow the need itself is any greater in an area of high unemployment as an area of high employment.

I know the mayor of Farmers Branch, for example, who is sitting here in the audience, he has told me, and we all know, that even in that city, which has relatively high employment, the problem of a shortage of math and science teachers is just as acute as anywhere else.

Reverend BYRON. I tend to respond in terms of my own experiences, as a prep school math teacher when Sputnik went up, and there was a flurry of interest. As you were asking your question, I was thinking of where did those young men go, the ones that I was teaching. They're all over. They're in California, they're in Texas. I taught in the Northeast and, of course, a lot of them are there and are in their professions.

So when you are looking at a national problem and you're looking at the development of human potential to deal with that problem, you have got just to assume portability. So to target it by region for the development of persons I think might not be good national policy. To target by region for the development of facilities might make better national policy, because the facilities don't move around.

Mr. SIMON. Mr. Williams.

Mr. WILLIAMS. Thank you, Mr. Chairman. I appreciate the testimony of the witnesses today, and I can't help but notice these last couple of days of math and science hearings our questions have been answered with a unique precision that we don't normally find.

Because we have another excellent panel to go, I will confine myself to posing just one question, Mr. Chairman.

Recently a report was completed by the National Science Board and National Science Foundation. The title of the report is "Today's Problems, Tomorrow's Crises, a Report of the National Science Board Commission on Precollege Education in Mathemtics, Science and Technology." The report tells us that we have found that in mathematics, science, and engineering wide differences persist in achievement and in participation levels among students from different social groups. Women have traditionally participated less than men in the sciences, and members of various minority groups—and out my way in Montana we have a growing concern about participation and the education level of the American Indians, but there are other minority groups as well, including, of course, black Americans and Mexican Americans, and Puerto Rican Americans.

The report has found that these and other minority groups have participated less and performed less well on standard science and mathematic achievement tests than their white counterparts. Approximately 20 percentage points separated the mathematics achievement scores of 17-year-old black and white students on national assessment tests in 1973. In 1975, we conducted the national assessment tests again and found that the disparity was still as great, if not greater.

We have heard from this panel, as we have from many other panels, that perhaps the Federal Government cannot do all things. But this is one area in which the Federal Government has acted, in my judgment, in a fairly significant way, to establish some equality of opportunity for education among all our people in the land.

Well, if it is true that the Federal Government can't do it all, let me ask what I hope is not an unfair question: What is the education community and your universities and colleges in particular doing to help reduce this great disparity which this Nation simply cannot afford?

Reverend BYRON. I think it would take a long time to answer that in detail because you get into program by program. I think all of us would agree that there is an ongoing commitment in the higher education community, institution by institution, to deal with the problem.

I just want to make sure I've got the problem. You're just saying the disparity as shown in test results of the—I'll put it this way, that the white children of the Northeastern part of the United States are doing a whole lot better in SAT scores than black and Hispanic youngsters elsewhere in the country. The data are showing that. As I am hearing you, you're saying what is the higher education establishment trying to do to close that gap.

Mr. WILLIAMS. And to close what is, of course, the resultant gap of the participation level between these various groups as mathematicians, scientists, and engineers.

Reverend BYRON. Let me give you one concrete example and then I will yield to the others.

Here in Washington, at Catholic University, I just started there on the 1st of September. I asked that an initiative be taken toward the private sector institutions, corporations in this area, in what we called a partnership program. We said it is to educate minority students—of course, in this community it would be primarily blacks and Hispanics. We went to major corporations and entities and said, "If you will commit yourself to a youngster at the level of $3,000 a year for 4 years, the institution will match that commitment at $3,000. And we will give support services, but we want to bring youngsters in from the minority community." We aren't getting a very enthusiastic response to that. We're getting some but, frankly, it is quite disappointing.

We do have a so-called partnership program in place, but we find we're the sole partners. We are putting up the entire amount, and that is coming out of tuition payments of other kids. That sort of thing simply cannot go on. It is unfunded student aid and we're putting it out in that direction.

Now, once the youngster is there, that is, of course, just the beginning. What do we do when they are there? We find that if we give them the opportunity to get into the normal pattern, that they will catch up. They get additional help, but we don't set them aside as a special category. We are making a conscious effort to try to have a retention program of minority youngsters in engineering, science, and engineering, in our school of engineering, and we are asking another major corporation for assistance in that regard. But this is a slow process, and for every youngster who stays in there for 4 years and gets the degree, you have got a victory. There are some small victories, but the task ahead is a whole lot larger than we are able to deal with.

Dr. **Ikenberry**. I would just cite quickly three specific examples that the University of Illinois is involved with.

In the field of engineering we have what we call a principal scholars program that is designed at the high school level to identify promising minority youngsters who are interested in pursuing ultimately a career in the field of science and engineering. We work with them at the high school level during the academic year and during summer programs and so forth to make sure that their basic preparation moves along rapidly enough so that they are able to enter as freshmen at the University of Illinois, or other universities and colleges. They don't necessarily all come to us. We work with them early in the secondary schools and with the local school system to identify promising young people and make sure that they get the special help they need to jump the hurdle.

A second program is along the same lines but is in the field of the health care professions. We are working with school systems, particularly in the city of Chicago, to identify particularly minority youngsters who are interested in pursuing careers in the health professions—medicine, dentistry, pharmacy and so forth, nursing. And students, if they fail to gain adequate competence in math and science at the secondary level, and in their baccalaureate preparation cannot then go on to pursue professional programs in, let's say, medicine or dentistry, again we are working at the high school level to identify these students early to introduce them into the health professions and to counsel them and help them get the basic science and mathematic competencies that they will need to pursue careers.

A third area that we are working with is with the Chicago City schools generally to provide special enrichment programs, not just for minority students but for all students, who have special gifts in science and mathematics, to provide the weekend and summer program enrichment programs in cooperation with the Museum of Science and Industry and other cultural and educational institutions in the Chicago area to try to develop the human resource of that city to the highest level possible.

Those are just three examples that come to mind.

Mr. WILLIAMS. Thank you.

Dr. ELLISON. Mr. Chairman, Mr. Williams, I would just give a couple of examples, also, of the approaches that we take, and they are similar to those that have been described by President Ikenberry.

I did pass out, and I think you have it in front of you, the specific program that I was making reference to. The Cleveland Space Odyssey, which was a joint partnership arrangement with NASA [Lewis], the Center for Science in our college, that is a cooperative mechanism that will allow us to systematically work with the 32 school districts in the county.

With respect specifically to quality, however, and minority students and students who tend to achieve at a much lower level than those who have obviously taken advantage of opportunities and who are scoring better on SAT tests and other measures, we have a huge institutional commitment to developmental education, which is an area of institutional programing that as a community college we have not turned out backs on because we have maintained and do maintain the commitment to an open door policy.

With respect to developmental education, we have sought out partnership arrangements, as the father was mentioning a few minutes ago, with business and industry. My comment about the PLATO system, the application of computer technology in both basic skills education as well as in general scientific understanding. The computer and the computer application in the classroom is probably one of the most appealing tools that we have now, that will help young people be reexcited about discovery and opportunity for learning. Indeed, the Center of the Space Program with the schools and with NASA was based around the questions of computer technology and the things that are happening now in that broad area.

So, on the quality side, we are maintaining as many institutions are a commitment to developmental or basic supports to enhance, to stimulate, to motivate students forward.

On the participation side, our efforts are to keep tuition as low as we can so that students who come from the public schools—incidentally, the 28,000 students that were mentioned as being enrolled in our institution, a local community college, the average age is 28 this year. So, when we talk about students in the community college arena, we are talking about adults, in large part, who are coming back to our institution.

We have articulation programs that were described by President Ikenberry with not only local school districts but with the universities, so there is a career sequence that students, hopefully, will enter into and move forward. Our biggest commitment, however, had to do with location. In 1968 we made, in Cleveland, the largest single commitment—I think it's on record—in America, to locate a new institution downtown. We spent $40 million, the largest single investment in our city for a new institution in the middle sixties. We are located downtown. We are in the middle of the ethnic and minority communities, so we put our money where our hearts were—and that is before I arrived at that institution.

We have a new $9 million high technology skill training center that is going up on that site today. That will be both a motivator and stimulator at the quality level, of what can happen if a student will simply aspire to move with us in that environment. We are moving with a new set of agreements with private industry to make sure that those facilities and those commitments to the city, where large numbers of minority students who are not achieving well, where large numbers of women are coming back to the institution, large numbers of single parents, displaced homemakers, who are single parent breadwinners now, that are going into the automated electronic offices of the future.

Our program in word processiong and data processing and office administration today will be manned or peopled by and large by an awful lot of women today who are looking to be and are sole supporters of households. They are going to learn those skills on our campus, close to home, capable of operating out of that environment.

I cite mine as an example. I suspect we have thousands of them across the country. I think has to do as much with will and commitment as it does to specific examples.

Mr. WILLIAMS. In concluding, Mr. Chairman, I would say what I have said before in this committee hearing room, and that is that we are quickly approaching a math and science crisis, and in trying to resolve it we should not ignore the great, virtually untapped load of potential mathematicians and scientists who are out there as women and other American minorities. They may well be the midterm and then longrun answer to this shortage.

Thank you, Mr. Chairman.

Mr. SIMON. Thank you.

I don't want to prolong this, but one quick question to Father Byron. One of the suggestions you make that is not part of our bill is the faculty renewal award idea. I have to say it has some appeal to me. But you are suggesting a $20 million program. For the purposes of this proposal, we would have to scale that down appreciably.

If that were scaled down, say even to 10 percent, so you're talking about 300 awards every year instead of 3,000, when you scale it down that much is it still a meaningful thing? Is it still something that ought to be done?

Reverend BYRON. Yes; it is. I would say it still should be done, that it carries with it prestige, and at least they will get a little psychic income if the stipend is just barely adequate. I think it is a good thing and it can always be built upon.

Mr. SIMON. I thank you, and I thank all three. You have been very patient and we appreciate it.

Revevend BYRON. Thank you very much.

Mr. IKENBERRY. Thank you, Mr. Chairman.

Mr. SIMON. Our final panel—and they deserve an even greater patience award than the three witnesses you have just heard—are David Moreau, E. Walter LeFevre, Charles Ruch, William Kelly, Robert Gaither, and Stephen Willoughby.

I am going to modify the order of the panel as it is listed here in order to give our colleague from Montana, a very respected member of this committee, and now a member of suddenly new power because he is a member of the Budget Committee, also. I am going to call on our colleague from Montana, Pat Williams, to introduce the dean of the college of letters and sciences at Montana State University.

Mr. WILLIAMS. Thank you very much, Mr. Chairman. I appreciate that kindness and I am pleased to welcome a fellow Montanan to this panel, the immediate past president of the American Association of Physics Teachers, Dr. William Kelly.

Bill Kelly has served for the past 4 years as the dean of Montana State University's College of Letters and Sciences, and he was previously the chairman of the physics department at Michigan State University. We are always pleased at this distance to have a Montanan, Bill, and we are particularly pleased today to have one of your stature.

Mr. KELLY. Thank you, Pat. I appreciate that very much.

Mr. SIMON. I think what we will do, we will call on you first, Dean Kelly, and then proceed with the other panel members and hear from all the panel. We will then have questions.

STATEMENT OF WILLIAM KELLY, DEAN, COLLEGE OF LETTERS AND SCIENCES, MONTANA STATE UNIVERSITY, ACCOMPANIED BY JOHN W. LAYMAN AND JACK M. WILSON

Mr. KELLY. Thank you, Mr. Simon, and thank you, Pat, and thank you, members of the committee.

I am a little disappointed that Mr. Perkins left early because I wanted to compliment him on some of the initiatives that are being taken in his State to solve this problem. Kentucky is one of the leaders in that.

As Pat Williams just mentioned, I appear wearing two hats, one as a representative of my university and college, and the other as a representative of the American Association of Physics Teachers. The AAPT, as we call it, just completed its annual meeting in New York this week, and as a part of that exercise, we had a number of sessions dealing with the crisis in engineering and mathematics and science teaching. You might be pleased to know that the council of that body voted unanimously a resolution of appreciation to the sponsors of this bill, and I wanted to relay that information to you and commend you for the stands that you are taking.

This is, indeed, a very serious problem. I was struck this morning in listening to the other testimony, I don't think I have ever been in a room hearing testimony and participating in which I have agreed more with more people. It is something that we really need to give a lot of attention to.

I think the bill that you are proposing here is one that is moving in the right direction. I do have some problems with it, though, and let me turn to some of those problems.

Mr. SIMON. Incidentally, for all the witnesses, we will enter your full statements in the record, and then you may proceed informally or however you wish.

Mr. KELLY. What you will find, if you take my verbal remarks and the written remarks, you will get more for the money than you would by themselves.

As I mentioned, the problems are great. Now, let me give you an example of how extensive the problem is and how it compares with some of our foreign neighbors, some of our foreign competitors, if you will.

We learned just this last week that a magazine that we publish called The Physics Teacher, which we distribute to something like 9,000 teachers in this country, also goes to the Soviet Union. In the Soviet Union they translate a number of the articles from each of the journals and then distribute those along with a similar journal to something like 150,000 people. The impact of that can be very great.

Another example. We had a small delegation of our association that attended a conference, an international conference, in the People's Republic of China, and as a part of that activity they visited eight of the major universities in China. They saw the classrooms in action; they saw the teaching laboratories, and so on. They came back with the information that in the average of those universities the students are getting significantly more exposure to the laboratory work than the corresponding students in this country.

In addition, when they took a look at the apparatus that is there, they found that the equipment is better, is more modern, and in some ways is more imaginative, a more imaginative use of all the techniques that are involved. So, I think we have some real concerns.

You mentioned yourself, Mr. Chairman, this morning a concern for the foreign languages. I agree with you wholeheartedly in that. This is an issue that is a very serious one; it is one that is going to grow with time. I think we do need to address that.

But, I think, what we are in now is a situation where we have something like a person who has been injured, has had one of his limbs injured in an accident. All those limbs are important, and they all need to be taken care of. But the ones that need to be addressed are the ones that are hurt the most seriously. I think that is the situation we are in.

In the prepared testimony that I have here for you, we indicate a number of priorities that we would like to see, and let me mention some of those. Teacher training and re-training, aided through forgivable loans, for students planning to be teachers. Summer academic institutes. Support for the modernization and maintenance of equipment. And then, also, I think in order to attack this whole problem, there needs to be a very coordinated approach involving not just the educational community but the entire educational community, industry, and so on.

I was very pleased to see the amendment that Pat Williams has introduced calling for support of public awareness programs in science. I would like to urge the support of that, because we need to educate the public much more with regard to the importance of science and mathematics education with the importance of education generally. So, I would like to encourage that kind of support.

I do have one reservation regarding that amendment, though, and that is it calls for matching funds. This kind of a program, where it exists, is a very low priority kind of a program in the nonprofit institutions. We have a small program at Montana State, a very small one. It is on the endangered species list because of anticipated budget cuts. To come up with matching funds I would have to literally cut classes in some of the areas we're talking about, where we need to make preparation. That's a difficult choice to have to make.

To give you an example as to how large the modernization of equipment problem is, I did a survey in my own college of just the science areas only. I asked the department heads to give me the information as to the total amount of dollars it would take to modernize their laboratories so that they would be teaching state-of-the-art concepts with state-of-the-art equipment. That total estimate was $2.5 million.

Now, if I have to come up with the money for that from my own budget, it will take me 50 years to do it. With the matching kind of requirement that you are mentioning here, that number gets reduced to 34 years. So I have a real problem with it. Somehow, with the way knowledge is advancing, I think my equipment will be out of date before it can be replaced again. So, I would like to call attention to that.

I'm concerned about the possibility that the block grant approach will be used in the distribution of the money to the precollege institutions. The difficulty there is that the total amount of money that is available is very, very small. If you consider the average dollars per school district, that's going to turn out to be about $14,000. If you then say we're going to divide it amongst the half a dozen different scientific disciplines, then you're talking about a couple of thousand dollars. Then if you talk about dividing it amongst the different schools, the different number of high schools, the different elementary schools, different junior high schools, you're down to just a few hundred dollars per school, per discipline. That's just not enough to really make an impact.

I think we would be well advised to devise a better way of targeting the money to specific programs where the decision to support the program would be based upon the qualities of the proposals, the qualities of the program to be developed, and the quality of the output that is likely to come out. To achieve that, one would need to develop a system of peer review, peer evaluation, involving experts who are known for their expertise in the areas of teaching and the areas of the discipline—I cannot emphasize areas of the discipline too much—and also who are known for the quality of their judgment and for their ability to be objective. Without that kind of peer review and evaluation, I think that the programs are doomed to failure at the very beginning.

Again, I commend you for the steps that you are taking, and I would like to offer whatever services I can give and that the American Association of Physics Teachers can give to help you solve those problems.

I would like to call your attention to the appendix that is in our report, which lists approximately a couple of dozen possible solutions to the problem. We will be happy to discuss those with you at some time if you would like.

Thank you.

[The prepared statement of William Kelly follows:]

PREPARED STATEMENT OF WILLIAM H. KELLY, PAST PRESIDENT, AMERICAN ASSOCIATION OF PHYSICS TEACHERS

The American Association of Physics Teachers expresses its appreciation to the members of Congress who have sponsored H.R. 30 (Mr. Perkins, M. Simon, Mr. Goodling, Mr. Ford, Mr. Biaggi, Mr. Williams, Mr. Weiss, Mr. Lehman, Mr. Oberstar, Mr. Smith, Mr. Rahall, Mr. Bevill and Mr. Boucher).

We appreciate their recognition of the desperate situation that exists in the United States today in regard to pre-college and post-secondary education and training in science and mathematics and their perception of the critical impact that the present shortages of qualified teachers implies in terms of the long-range improvement of our national technical leadership and industrial productivity.

Recognizing the stringent budget restrictions currently necessary at the national and local levels, we urge that appropriations be well focused to ensure that the funds reaching local programs be sufficient to have an appreciable triggering effect for local effort. To achieve this concentration of effort in the mathematical and scientific areas where there now exist critical shortages of qualified teachers and educational efforts, we recommend strong federal support of nationwide programs of:

1. Teacher training and retraining aided through (a) forgivable loans for students training to be teachers; (b) summer academic institutes at universities designed to improve and update the knowledge and abilities of practicing teachers;
2. Support for the modernization and maintenance of instructional equipment;
3. Informing the public concerning the importance of mathematics and science.

The Association hopes that all members of Congress will recognize that national excellence in education in mathematics, science and technology is a major foundation upon which the United States can build a secure future. We hope that the Congress will see that strong federal leadership in this area is essential to our national distinctiveness and survival.

INTRODUCTION

The American Association of Physics Teachers is a professional organization consisting of teachers in high school, two-year, and four-year colleges and universities. Its approximately 9,000 members are actively engaged in the improvement of the teaching of physics and astronomy at all levels ranging from elementary school through graduate work in the universities. The Association has been concerned about the shortages of science and mathematics teachers for several years, and has been searching for solutions to the resultant problems.

The AAPT has been cooperating with the National Science Teachers Association in data surveys to determine the magnitude of the teacher shortages and some of the impacts of those shortages. We are familar with the wirtten testimony presented by the NSTA on January 27, 1983, and are in general agreement with most of the points made in the document. However, we do differ with some of their remarks concerning the NSF and believe that portions of the H.R. 30 bill might be administered out of the Office of Education under certain circumstances. We share the concerns about the apparent lack of sensitivity of the National Science Board to the problems of science and math educators. However, in the past the Department of Education has also been insensitive to many of the same problems.

I will also be testifying as the Dean of the College of Letters and Science of Montana State University which is in the District of Representative Pat Williams, one of the Sponsors of H.R. 30 and the initiator of an amendment to that bill. I will also testify in support of that amendment.

Much data have been published recently concerning the shortages, and some are summarized in the written testimony of NSTA. These data will not be repeated here, instead we will present additional data specific to a couple of states and other information concerning the situation in the USSR and the People's Republic of China as compared to that in the U.S.A. These will help to emphasize the enormity of the current situation.

There is a very strong need for a broad coordinating program. The problems have to be attached at all levels, including major programs of educating the public concerning the importance of education and of teachers of science and mathematics especially. At the same time we cannot overlook the humanities and foreign languages. Science and mathmatics have to be placed in perspective, and the interaction with peoples of other languages and other cultures will be increasingly important with time. The problems are gigantic and the costs are enormous. However, the problems and costs of not acting will be even greater. As a bumper sticker on a Bozeman, Montana car says, "If you think education is expensive, wait until you see the cost of ignorance."

Education in science and mathematics is absolutely essential to the defense and security of this nation. It is probably more important than most of the different weapons systems and should be viewed as such.

The commitments made by Congress will have to be long-term commitments. Turning on a program for a few years and then turning it off will be devastating.

THE PROBLEMS OF TEACHER SHORTAGES

As an example of the magnitude of the problem, consider the case in Texas. There are approximately 3,000 teachers of physics and physical science in the Texas school system. About 500 of these leave teaching each year. There are 150 institutions in Texas that produce teachers. In recent years there were on the average only 10 students each year graduating prepared to teach physics. Of these, six do not go into teaching because of competing salaries in industry and business.

Approximately 70 percent of all junior high physical science teachers in Texas lack certification requirements; they are teaching on emergency permits. A survey taken about 10 years ago showed that about 60 percent of these teachers had taken no further course in physics or chemistry since the ninth grade (which they were teaching at the time).

This situation in Texas is fairly typical of those in other states. A national survey of college programs for the preparation of elementary school teachers showed that 82 percent of the programs require no science in the curriculum.

In the spring of 1981 the Texas section of the AAPT decided to honor five high school physics teachers for their outstanding teaching of physics. When they tried to contact these teachers in the fall of 1981, three of the five had left teaching for better paying jobs in business and industry.

The AAPT publishes a magazine called The Physics Teacher which has approximately 9,000 subscribers. It is designed to be of most help to the high school physics teacher. We have recently learned that in the USSR a substantial number of articles have been translated into Russian and distributed in or with their equivalent journal to approximately 150,000 physics teachers.

The AAPT recently sent a small delegation of physics faculty members to the People's Republic of China. The delegation visited eight major universities in that country and learned that the physics majors have much more lab work than students in this country and have equipment that is often better than that found in our college and university instructional laboratories. In addition, the students are taught much more math and science in their high school programs.

In the January 24, 1983, issue of The New Yorker, the widely known American investment banker Felix George Rohatyn, is quoted as saying, "The thing about Japanese competition, by the way, was brought home to me in a conversation I had with the physicist I. I. Rabi. He said that we wouldn't be able to compete with the Japanese for the next twenty years, because we didn't have teachers who knew how to teach technology. From what I have been reading, I have come to the conclusion that Japanese productivity seems to have most to do with their primary- and secondary-school systems, and not at all with their quality-control circles and labor rates."

I recently surveyed the instructional equipment needed by the science and mathematics departments in my own College of Letters and Science at Montana State University in order to moderise their programs and to present the essential experiments as they should be done. The total amount needed is over $2,500,000. Much of the current equipment is obsolete, 10–20 years old. A significant fraction of that equipment is not working properly. With my present budget it would take approximately 50 years to replace that equipment (34 years if the proposed matching grant requirement in H.R. 30 is held). From our observation as we have visited other science departments in other universities, our situation is more typical then it is unusual.

REASONS FOR THE TEACHER SHORTAGE PROBLEMS

Teachers' salaries are a big contributor to the current problems, and the problems are enormous. Let me cite some other reasons. The following is a fairly accurate description of the conditions under which the average teacher operates—and the problems are worse in the lower grades:

1. The teacher does not understand adequately the concepts being taught;
2. The teacher lacks knowledge of technological applications of the material;

3. The teachers often cannot modify the axiomatic treatment in the text to a more experimental approach that would be more easily understood by the students;

4. The school budget does not provide adequate materials and equipment to make the modifications that would be needed for the more experimental approach;

5. The teacher has no time for such modifications if he/she were capable of making them. Much of their time goes to filling out endless forms for one government agency or another;

6. The teacher will not be able to get the funds from the school administration even if he/she had the time and the knowledge to do so;

7. The teacher will not receive adequate salary recognition even if he/she completes the certification requirements for teaching;

8. There is little chance for advancement as a science teacher, but they do advance if they move out of teaching into administration, etc.

The Universities and Colleges contribute to the problems. In most institutions there is very little interaction between those faculty teaching the subject matter courses and those faculty teaching the education methods courses. The demands on the students majoring in education and the expectations of them are often conflicting. The faculty in the subject matter areas tend to look down upon the students going into teaching, and this attitude is felt by the students. this faculty attitude is simply a manifestation of the attitude of the public toward our teachers. The low salaries, the low school budgets, and expressed opinions by the public are other manifestations. There is a strong need to educate the public to the fact that teachers are very important and should be rewarded accordingly.

THE BILL: H.R. 30

Part A—Elementary and Secondary Assistance

We generally support the bill, but do have some reservations concerning it. The total amount available after subtraction of 5 percent for administration, is $237,500,000. This amounts to an approximate average of $14,000 per school district. This is to be divided among physics, mathematics, chemistry, biology, earth sciences, and perhaps others. (The bill is vague about the eligibility of the social sciences.) This means an average of about $2800 per subject area. Most districts have more than one high school, several junior high schools, and even more elementary schools. Let us assume two of each school for the district, on the average. There will then be between $400 and $500 to spend in each school in each subject area. Considering the current state of affairs in most school districts, this is an unreasonably small amount to accomplish anything significant. Consequently, the focus of the program should not be broadended. In fact, one might consider narrowing the focus to mathematics and the physical sciences.

Therefore, we recommend that a few programs that will have a significant impact be targeted and that block grants based upon the number of students be replaced by a granting system based upon the merits of specific proposed programs and the merits of the people involved. The grants awarded should be determined from the reviews of the proposed programs made by peers who are experts in the subject areas and method areas involved and who are respected for the quality and objectivity of their judgment.

This peer review approach will give more assurance of quality control than the block grant system. As a result, faculty and public opinions of the programs will be higher. This kind of support will be urgently needed. For school districts where the needed expertise for the development of strong programs is absent, a system involving special consultants can be developed as an alternative.

In-service training and retraining programs and the modernization of equipment should be given the higher priorities. The training programs must involve experts from the subject matter areas since the teachers often lack the necessary confidence that mastery of the subject matter gives. (In fact, many of these teachers lack confidence in science and mathematics, and this is often communicated to the students.) Use of the emerging technologies should be included in these programs.

It must be kept in mind that the need for teachers is more critical in physics, mathematics, and chemistry than they are in the other science areas. Priorities should be developed accordingly.

Part B—Post-Secondary Assistance

Congressional scholarships

The Congressional Scholarships Program is an excellent way to proceed. With proper publicity, this can be made a prestige program that can be attractive to prospective teachers. These funds should be supplemented so that many more teachers can be reached. Six hundred scholarships per year is a drop in the bucket compared to the needs. However, five years of teaching for two years of tuition and fees is out of line as far as costs are concerned. A year's service for a year's tuition and fees would be more within reason. Partial forgiveness of this loan should be possible with each year's service. A teacher who learns that he or she is unsuited to teaching should not be forced to stay in teaching. No one gains under such circumstances.

Summer institutes

Summer Institutes and Workships for teachers of mathematics and science are important and should be funded. The offering of such institutes and workshops must involve university and college faculty from subject matter areas. The teachers need information and skills that would be provided and the confidence that they would gain from having both the skills and the information.

The actual selection of Institutes and Workshops should be based upon the quality of proposals and faculty as determined from reviews by peers who are familiar with the subject matter and the methods to be used and who are known for their quality and objectivity of judgment.

There have been some exciting and interesting developments in recent years in determining how students learn science and mathematics. These developments can have important impacts on how we teach different students at different levels. Most of these results have been obtained by research groups in universities. This research is important and should be encouraged. The monies designated for the National Institute of Education should be available in part to support these kinds of programs as well.

Much research needs to be conducted into curriculum development and in the applications of new technologies in teaching. These must be supported if progress is to be made.

Upgrading laboratory equipment and facilities

This is an extremely important need. However, the two in three matching fund requirement will exacerbate the inequalities that now exist. The richer universities and colleges will have the matching funds and will be able to participate. At the other extreme, where the needs are more critical, the least affluent colleges and universities will be unable to participate. Many institutions are in budget-cutting situations because of the state of the economy and, as a result, will find it difficult to participate if they can participate at all.

Challenge grants imply the participation of industries and business. These organizations tend to "give where they live." Rural states and low population states, such as Montana, do not have many such opportunities and yet the educational needs are large. Businesses and industries are limited in the amount of such help that they can give. Tax incentives for business, industry, and individuals could be helpful.

At Montana State University for example I would have to drastically reduce the number of classes to be offered in these areas of shortages in order to participate at a meaningful level. Montana State University is not unique in this situatuion. The financial condition of the majority of the other institutions of higher education is similar. There is very little, if any, budget flexibility.

Large matching grant programs with the states would be a strong incentive for the states to act. State legislators might be susceptible to making unusual allocations if they were convinced of the needs and if they could see how their allocations could be leveraged.

AMENDMENT TO H.R. 30 OFFERED BY MR. WILLIAMS OF MONTANA

The amendment offered by Mr. Williams of Montana calls for the development of a grants program for public information programs about science and mathematics in contemparary society. We are very strongly supportive of this amendment. The public must be educated more concerning the importance of science and mathematics so that it can be better ready to deal with the increasing technologies and to become more productive in the future. The public also needs this program in order to become more supportive of the needs of education.

The proposed use of a review panel involving eminent and experienced advisors is essential to assure high quality, accurate, and objective programming.

We have one serious reservation regarding the amendment, however. Very few non-profit institutions, if any, will have the resources needed to participate in this kind of activity if matching funds are required. Where this activity still exists now in universities and colleges, it is of low priority because of critical needs in other areas, and is thus an endangered species. A one part institutional to five parts federal grant would be more appropriate.

OTHER PROPOSED SOLUTIONS TO THE CRISIS FROM THE AMERICAN ASSOCIATION OF PHYSICS TEACHERS

The American Association of Physics Teachers has a Committee on the Crisis in Science and Engineering Education (Chaired by William H. Kelly). In its meeting of January 24, 1983, the Committee developed a list of Potential Solutions to the crisis. The more general of these solutions are included in Appendix A. The solutions are a preliminary attempt at focusing activities, and we continue to develop others.

The AAPT is strongly committed to do everything it can to solve the problems that exist in science and mathematics teaching. It will willingly and happily work with other professional associations to achieve these goals.

AAPT HIGH SCHOOL TEACHER SHORTAGE, POTENTIAL SOLUTIONS, RANKED FINAL LIST

The American Association of Physics Teachers feels that the crisis in science and mathematics teaching is well documented and that the time has come for the Association to purpose some solutions for this crisis.

An original list of Proposed Solutions and a rating sheet were mailed to all members of the Crisis Committee, the High School Committee, the Executive Board, the Section Representatives, and others in advance of the New York national meeting.

At the New York meeting these Proposed Solutions received widespread discussion with input from all interested and concerned parties. These Proposed Solutions now stand as AAPT Proposed Solutions. They are ranked in order of their perceived importance but this is not absolute. Each Potential Solution will have to be judged according to the local science and resources.

All persons have some responsibility for adopting some of the Proposed Solutions. Some are amendable to Association responsibility, some to local, state, and national efforts. No singular solution will be the cure all.

These Potential Solutions will be useful for those preparing testimony for Congress and may be given to the National Science Board's Commission on Precollege Education in Mathematics, Science, and Technology, which is beginning Phase III of its work which involves providing specific suggestions for solutions for the problems addressed by our Potential Solutions set.

The AAPT Crisis Committee will still elaborate on each of the solutions providing more detailed suggestions.

None of the original Potential Solutions were eliminated since all fell above the 3.0 level. Some Potential Solutions were added to the list but were not subjected to the ranking and valuing procedures of the original set.

The Association must have evidence of solution attempts and level of success. If you know of such efforts please send appropriate documentation to Dr. John W. Layman, Physics Department, University of Maryland, College Park, Maryland 20742.

AAPT Ranked Potential Solutions Set. Each Potential Solutions value on the scale of 5 (Top Priority), 4 (High Priority), 3 (Neutral), 2 (Low Priority), 1 (Eliminate) is also provided.

1. Short term intensive summer workshops. (Value 4.6.)

Immediate upgrading of underprepared teachers and modernization of the equipment and technological background of the prepared teacher are both needed. Short term workshops that don't consume a whole summer may be an excellent solution.

Layman suggested a three tiered format. A two week intensive workshop for the well prepared teachers to upgrade their laboratory equipment and skills, perhaps including the area of microcomputers as well as other types of equipment. The next two weeks could be a workshop for underprepared teachers with support coming from the prepared group. A buddy system of a prepared teacher with each underprepared teacher would offer long term support after the close of the workshop. If there are any pre-service teachers in training, they should receive summer support for serving as assistants and as informal participants in the summer program.

2. Retraining programs. (Value 4.55.)

A finite number of programs should be established to allow critical masses of underprepared teachers to come together for retraining in subject matter competence and teaching skills. Physics teaching differs to some extent in character from areas such as chemistry, biology, and mathematics. When a physics teacher retires from teaching or goes into industry, someone with training in another area is frequently selected to cover the one or two physics classes that must be taught. Help must be given these persons to improve their subject matter competence and teaching skills and enable them to achieve certification.

However, if much of the physics teaching is done by underprepared persons just filling in, most of the professional concerns expressed nationally and within AAPT are not going to be addressed. A supply of teachers who have majored in physics and prepared themselves for teaching must be provided if future generations of students are to benefit from the insights arising out of this type of commitment. This is especially true if we are to have advanced programs, or if we are going to increase the number of students enrolled in high school physics.

States in conjunction with professional societies should determine the qualifications required for proper instruction in science and mathematics, monitor the qualifications of all teachers, and require that those underprepared, undertake course work in the field in which they teach.

3. Student loans. (Value 4.2.)

Full tuition and living expenses could be provided with student loans. These loans would be forgiven on a year for year basis if the student then enters teaching. Monies the this could be provided by a state, the federal government, or through industrial support. Some states have begun to introduce such programs and this was a feature of recently introduced bills in the House and Senate that were not passed.

4. Enhancement of teacher salaries. (Value 4.1.)

Local, state, federal, or industrial funds could be provided to extend the physics teacher's teaching contract to eleven months with a concomitent increase in salary. This would provide additional support for the teacher's curriculum and laboratory development efforts, for equipment construction and repair, and for joint planning on the part of a number of teachers in larger districts or regions. Some summer periods might be spent working in industrial or academic laboratories to sharpen the teacher's awareness of and participation in the real world of science. Salaries would then be more competitive with industry.

The AAPT could certainly supply summer professional programs for teachers with extended contracts.

One other suggestion was that we create the postition of Science Fair Coach, so that enhancement of pay could occur within present systems.

5. Better equipment and laboratory facilities. (Value 4.05.)

Little money has been available in recent years for laboratory equipment or for improvement in facilities. Laboratory work is the backbone of a strong physics program and good teachers would become less discouraged if this kind of support became available. Industrial support would be most welcome in this area.

6. Special regional centers for training/retraining of teachers. (Value 3.9.)

Rather than each institution trying to mount small programs for training or retraining teachers, regional centers with appropriate resource and faculty could be formed. Such carefully planned moderately sized programs would perhaps insure a quality level not possible in small and scattered programs.

7. Tax incentives. (Value 3.85.)

Special tax incentives should be made available to industries who in some way support physics teachers, through summer jobs, equipment support, endowed chairs, etc. This too was a part of some of the legislation that was introduced but not passed by the 97th Congress.

Tax relief could also be offered teachers who devote some of their personal resources to equiping and supporting their own laboratory program. Many teachers do this now without such tax advantages.

8. Improved articulation of exit and entry skills of physics students. (Value 3.8.)

The Temporary Committee composed of members of the High School and Higher Education Area Committees are now working on both a high school physics syllabus, as well as entry level knowledge and skills needed by students planning to take introductory college physics courses.

9. Liaison with professional school board associations, etc. (Value 3.8.)

The AAPT has not in the past attempted to create a formal relationship with associations of school boards, science supervisors, school principals, or other outside the sciences groups that set policies affecting physics teaching. This could become an avenue of influence in the future.

10. Professional fund for teachers. (Value 3.8.)

Even skilled and experienced teachers of physics rarely find support for participation in their own professional societies at the local, state, or national level. One element that would help keep such teachers in our classrooms would be to provide such support. Monies for substitute pay should also be provided as part of such a fund. Source—local industry, chambers of commerce, etc.

11. First aid kit for the underprepared teacher. (Value 3.8.)

The High School Area Committee is now working on a First Aid Kit for the Underprepared Teacher. Help must be available for the underprepared teacher who is often pressed into service much against his or her better judgement and preference. Once this has occurred however, this person should be able to turn to AAPT for suggestions and help in physics teaching.

The best mechanism for dissemination of such materials would be a regional workshop conducted through a cooperative effort between a school district, a local college, and experienced high school and college teachers. The buddy system should be one of the services available through the workshop. The AAPT Sections throughout the country could play a major role in this process.

12. Buddy system—High school/college. (Value 3.7.)

The APS/AAPT Education Committee has already launched the College High School Interface Project (CHIP) to try to improve the relationship between local colleges and high schools. These are informal contacts but did not go so far as to encourage a one to one relationship between a high school and a college teacher. Such a system might be an improvement on the present system.

A buddy system between experienced and underexperienced high school physics teachers would be just as valuable.

13. Increased respect and sensitivity for the high school physics teachers. (Value 3.65.)

Recognition must be given to the crucial role that may be played by teachers who deal with physics in the schools. In spite of differences in background and level, we are all colleagues sharing the effort to educate persons in physics. Poor teaching occurs at all levels and in all institutions. The conditions for physics teaching have probably deteriorated more in the public schools than in most universities. Recognition of this must be made and support for local improvements given.

14. Minority oriented programs. (Value 3.45.)

Access to programs in physics and many other areas still remains a major problem for many minorities. Special efforts are in order to insure that all students have access to physics courses. The AAPT has a major federal grant to improve access to AAPT and APS meetings for faculty members from minority colleges. Little has been done at the high school level.

Perhaps a project aimed at recruiting minorities to teach physics would be appropriate.

15. Posters. (Value 3.45.)

There is a great need for posters and other forms of student incentives for considering the role of physics in many careers. Many students are now locked out of career options due to the lack of an awareness of this.

Montana State has produced an excellent brochure showing careers that require physics among other things as a background.

16. Endowed chairs. (Value 3.4.)

These could be supported by industry with endowment funds. The monies could be used to provide both additional salary as well as monies to be used by the teacher for participation in professional activities, subscriptions to professional journals, and perhaps money to purchase newer equipment.

17. Departmental physics teaching groups. (Value 3.4.)

Major physics departments could form physics teaching groups within their faculty. Such groups, even informal groups composed of persons whose sole duty is not a concern for teaching, could enhance and support the departmental concern for teaching. This group could also be concerned with the high school physics problems in the area of that institution. Too often, departments have one person who is reluctantly supported in these concerns, but no long term commitment shared among even a small set of the faculty is evident within the department or to other physics teachers in the region.

18. Computer supplemented programs. (Value 3.35.)

Microcomputers are finding their way into the schools in ever increasing numbers, but not into the science classrooms and laboratories. This device is exciting to both teachers and students. Skilled use by the teacher can bring about enhancement of labortories and demonstrations often showing phenomena that cannot be observed in normal laboratory experiments. It can also serve a support tool for record keeping and the production and modification of written teaching materials.

19. Research in physics education. (Value 3.3.)

Research in physics education must be supported to allow the profession to constantly strive to improve the teaching/learning of physics. This support for research is a major obligation of the whole physics community.

20. Public literacy in science and in science education. (Value 3.2.)

Public literary still remains a major concern of the profession. The AIP probably has the best track record in this area at this time. Underprepared teachers will not help solve this problem. The public needs to understand why science is important, and perhaps better understand the role that physics can play in a technologically based society.

21. Improved working conditions. (Value 3.15.)

Regardless of all other solutions, the physics community has an overall responsibility for the working conditions in the high school physics classrooms. If these are poor, and teachers feel that once they are in the classroom no other help or concern will be forthcoming, many will not stay in teaching even with improved salaries.

The Association should create a Working Conditions Check List that corresponds to the AAPT Guidelines for High Schools document so that teachers or others might rate a local program and work to bring about improvements for teachers and students.

22. Incentive programs for retired physicists to teach. (Value 3.05.)

Retirement income provisions could be modified to allow retired physicists or engineers to contribute to the teaching of physics. The APS Education Committee is spearheading an effort to involve retired physicists in such a program. Some might simply help support an underprepared teacher rather than assume teaching duties.

UNRANKED ADDED SOLUTIONS

23. Industry, as well as colleges and universities could make their instrument repair facilities available at reduced or no cost for science equipment repair.

24. Local districts could supply paraprofessional aids to support physics (science) teachers.

25. Make use of advanced technological communications means to reach isolated physics (science) teachers with courses and other teaching help.

26. The AAPT should maintain a syllabus collection so that teachers could refer to the work of others for guidance, especially in seeking information or models for a wide variety of courses.

Mr. SIMON. We thank you.

I also have a note here that you are accompanied by Dr. John Layman, the past president of the American Association of Physics Teachers, and Dr. Jack Wilson, the executive officer of that organization.

Mr. David Moreau, the acting dean of the College of Arts & Sciences, University of North Carolina.

STATEMENT OF DAVID MOREAU, ACTING DEAN, COLLEGE OF ARTS & SCIENCES, UNIVERSITY OF NORTH CAROLINA, CHAPEL HILL

Mr. MOREAU. Mr. Chairman, other members of the committee, I would like to take this occasion to thank you for the opportunity to focus your attention for a few moments on one particular aspect of science education; namely, the poor state of our stock of equipment that exists in higher education. Others on this panel, and others before us, have spoken very eloquently to the general nature of the declining health of our science education in the United States. I would like to call your attention to one particular aspect of that.

As a university administrator, I am almost daily confronted with a broad range of problems in science education, including salaries, equipment, buildings, curriculum. As a parent of two children in the public schools, and a vice president of a local PTSA, I am confronted with it as a community problem. But for the moment, let's concentrate on the question of scientific equipment.

With the recognition that North Carolina shared the Nation's problem in science education, the general administration of the University of North Carolina system was successful in securing a special State appropriation over the past 4 years of approximately $500,000 a year to upgrade this equipment in the two flagship institutions in the system, North Carolina State and the University of North Carolina at Chapel Hill.

The State legislature did what it could, but it recognized that that was only a bare start in addressing the problem. As such, and at the direction of a legislative research commission, the North Carolina Board of Science and Technology, again in September 1982, surveyed the status of equipment in all institutions of higher education in the State. That study produced an analysis that indicated that it would take $25 million simply to replace the 5 highest priority items in 174 departments and in only 11 institutions. The estimate was over $50 million to meet all of the needs that were reported in that study.

If you account for the effects of inflation, we are probably talking in the vicinity of $20 million a year simply to replace that stock. The average age of an item in that stock is about 8⅓ years, which is higher than the national average. Eleven percent of the equipment in the engineering disciplines is over 20 years old.

A second effort was made as a result of a special study of engineering and science education by a distinguished panel of consultants to the university system. As a result of that study, the board of governors has put before the current session of the legislature a special request of $5.5 million to be spent over a 2-year period in four of the institutions that are the most significant in their research equipment needs, research, and instructional equipment needs.

But that special request is in doubt in a period of revenue shortfalls. Just last week the Governor announced that the only item that he could recommend at this time in the expansion budget was the removal or the lifting of the freeze on salaries for all State employees which has been in effect for over a year, and that includes the salaries of the university faculty members.

Let me bring this now a little bit closer to home in terms of the college of arts and sciences, which undertook a study in support of that study by the North Carolina Board of Science and Technology. We did an item-by-item survey within the college of all pieces of equipment costing over $1,000. The purchase price of that stock is about $11 million. About half of it, 47 percent to be precise, was purchased with Federal research grants, and approximately half was bought on State funds, and approximately half of it by non-State funds. We estimate the depreciation rate on that equipment at about 16 percent a year, some in computer science running higher than that, and other disciplines somewhat more than that. That implies we need about $2.5 million a year simply to replace the existing stock.

The additional needs to upgrade those laboratories to reasonable standards are estimated at about $870,000 a year for the next 5 years, leaving us with a total annual need of approximately $3.5 million a year.

Our current funding levels are at approximately $700,000 a year, approximately 20 percent of the need. And even if we add to that another $700,000 from external sources, we are still meeting less than half the need for equipment. There is one particular point about that funding that concerns me particularly, the fact that 17 or 18 percent of that was generated from student laboratory fees. We are now talking about student laboratory fees for chemistry, physics, biological sciences, in the area of $30 a course. We are assuming that if we continue at that pace we are going to price people out of taking the science courses simply because of the laboratory fees.

If I may take just a couple of more moments, I would like to relate to you one particular illustration of the problem of funding the scientific equipment.

In 1880, the university began a long tradition of excellence in teaching in the field of chemistry. Dr. Francis Venable came to the University of North Carolina in 1880. Two of his early students proved to be great benefactors to the university, William Rand Keenan, Jr., and John Motley Moorehead. After a long and distinguished career in teaching in chemistry, Dr. Venable became president of the university, and in 1925, when a new chemistry building was completed, it was dedicated in his honor. Fifty-eight years later we are still teaching basic chemistry in Venable Hall.

After the centennial of Dr. Venable's appearance on the Chapel Hill campus, the State legislature in 1981 appropriated nearly $8 million to build a new modern facility for the teaching of undergraduate chemistry. By the time the bids had been received on that in the fall of 1982, we were a million dollars short, primarily in the area of instructional equipment. The university faced two choices—either build a shell for the building and wait to equip the laboratories, or reduce the scope of the project. After reaching the conclusion that we weren't going to get another million dollars out of the State legislature, and we would not be likely to get a grant for instructional equipment of that magnitude anywhere in the near future, we reluctantly made the decision to cut out one floor of the building, including a third of the freshmen labs, and a fourth of the sophomore chemistry labs. The building was not designed for expansion to start with; it was simply a replacement for those facilities. So nearly 60 years after Dr. Venable worked at placing that building in operation in 1925, we still are not able to replace that with a modern facility.

I am aware of your broad range of public needs before us in a time of insufficient funds, and I would not suggest that one can directly translate an investment in scientific equipment into reduced unemployment. I would hate to try to calculate the transfer coefficient, if you would, to make that translation. But I do think it can be reasonably argued that unless we invest in scientific equipment as well as the other factors of scientific education, we are likely to impede our economic progress and the generation of a larger pool of employment.

Thank you, sir.

[Prepared statement of David Moreau follows:]

PREPARED STATEMENT OF DAVID H. MOREAU, ACTING DEAN, COLLEGE OF ARTS AND SCIENCES, UNIVERSITY OF NORTH CAROLINA, CHAPEL HILL

Mr. Chairman, members of the Subcommittee, let me take this occasion to thank you for this opportunity to focus your attention for a few minutes on one particular aspect of science education in the US, namely the poor state of our stock of scientific equipment in institutions of higher education.

The general problem of the declining health of science education in America has been eloquently addressed by others on this panel and by other witnesses appearing before this Committee. Some of the problem is unique to higher education; some of it is clearly linked to problems of science education in the elementary and secondary schools. As a teacher and administrator in a state university with significant investments in science education, I am confronted with the problem almost daily in terms of salaries, equipment, buildings, and curriculum. As a parent of two children in the public schools and vice-president of a local PTSA, I am confronted with it as a community problem. However, in the few minutes I have here I would like to share with you some particular problems of funding needs for scientific equipment. The problem is a national problem, but I will draw upon our recent experiences in North Carolina, particularly our experiences at the University of North Carolina at Chapel Hill.

With the recognition that North Carolina shared the nation's problem in science education, and particularly the problem of worn-out and obsolete equipment, the General Administration of the UNC system was successful in securing a special state appropriation of $500,000 per year for scientific equipment over each of the past four years for its two flagship research universities, NC State and UNC-Chapel Hill. The legislature did what it could, but it knew that that appropriation would barely begin to address the problem. Therefore, at the request of a Legislative Research Commission the North Carolina Board of Science and Technology undertook a study in September 1982 to assess the status of scientific equipment in higher, education (see attachment I). The study produced an analysis based upon an item-by-item survey of 374 departments in all institutions of higher education in the state. Results of that study indicated an initial cost of $85 million for the existing inventory in the 16-member UNC System. To meet only the five highest priority items in each of 174 departments in only 11 of those institutions would require an expenditure of $23 million. Filling all the needs would require an expenditure of over $50 million. That study also indicated that the average age of an item of equipment in the inventory is 8.3 years, implying an average replacement rate of 12 percent a year. Over 11 percent of the stock located in the engineering disciplines is over 20 years old. If we account for the effects of inflation, the estimated annual replacement cost for that stock of equipment is in the vicinity of $20 million per year. That level of funding is clearly beyond the state's resources.

As a result of a special study of engineering and science education by a distinguished panel of outside consultants, the UNC Board of Governors put a special request before the current legislature for a one-time expenditure of $5.5 million for scientific equipment over a two year period in four institutions having the greatest problems (see attachment II). However, in these days of revenue shortfalls the fate of that special request is in doubt. Last week the Governor stated that the only item in the expansion budget that could be recommended for funding at this time is the lifting of a year-long freeze on salaries of state employees, including faculty.

I can bring the analysis a little closer to my own domain. In a study by the College of Arts and Sciences at UNC-Chaped Hill of scientific equipment, undertaken in support of the study by the Board of Science and Technology, we made a survey of the inventory and needs for scientific equipment for all items costing over $1000. The total purchase price of that inventory was approximately $11 million (see attachment III). Approximately half of the value of that inventory was purchased with non-state funds, mostly from federally-funded research projects. Replacement cost for the inventory was estimated at $16.4 million, indicating that the average cost of items in the inventory had increased by 54 percent since the time of purchase. Annual depreciation rates for the inventory were estimated to be 15.8 percent, resulting in an annual replacement need of $2.6 million. New equipment needed to upgrade laboratories to reasonable standards were estimated to cost $870 thousand over each of the next five years. The total of needs for upgrading and replacement comes to $3.5 million per year—in one division of a large research university.

Funding from state sources to meet needs in all departments in the College, not just the science departments, has averaged $705,000 per year over each of the last five years, and during the 1981-82 academic year 17 percent of those funds came from student laboratory fees. That rate of funding is only 20 percent of the estimated need.

If I may take just a bit more of your time I would like to give you a particular illustration of the problem of funding scientific equipment. Under the leadership of Dr. Francis Venable in 1880 the University began a long history of excellence in teaching and research in the field of chemistry. Dr. Venable later became president of the university, and in 1925 the new chemistry building was dedicated in his honor. Fifty-eight years later we are still teaching basic chemistry in that building. In 1981 the legislature approved a $7.7 million capital improvement project to replace that building and its contents with a new modern facility. However, by the time bids were received in the fall of 1982, inflation in the cost of laboratory equipment left us with a shortfall of $1.1 million. The options were to construct a shell and equip only a few of the labs or to reduce the scope of the project. After reaching the conclusion that an additional state appropriation or a grant to fund equipment needs was not a likely prospect, the decision was made to eliminate one floor of the building including one third of the freshman labs and one fourth of the sophomore labs. Thus, after nearly sixty years the University has been unable to fully replace the facilities in Venable Hall.

As an academic administrator and a public official serving on the board of a local utility, I am painfully aware of a broad array of public needs in a time of insufficient financial resources. But I am also aware of a fundamental change that is occurring in American industry and related employment opportunities. Our economic future, both at the state and national levels, is strongly related to scientific and technological advances. I do not suggest that investments in scientific equipment can be directly translated into reduced unemployment, but it can be reasonably argued that failures to invest in scientific equipment, as well as other factors of science education, can impede our economic growth.

ATTACHMENT I

State of North Carolina,
Office of the Governor,
Raleigh, N.C., December 10, 1982.

Hon Liston B. Ramsey,
Hon. W. Craig Lawing,
Cochairmen, Legislative Research Commission, North Carolina General Assembly, Raleigh, N.C.

Dear Senator Lawing and Representative Ramsey: The North Carolina Board of Science and Technology herein submits its initial report to the Legislative Research Commission on the status of scientific and technical equipment in the institutions of higher education in the state. This is in accord with the agreement set forth in your letter September 15, 1982 directing the Board to create an inventory and analysis of scientific in cooperation with the LRC Study Committee on College Science Equipment.

As requested, the Board is providing you with the following material:

1. A summary of the findings of the Board.
2. A compilation of 3–5 priority equipment needs of each department in the responding institutions.
3. An inventory of equipment items, by department, from the responding institutions.
4. An inventory of equipment by item from each of the responding institutions.

The material collected and presented to you is an important first step in an analysis of the status of scientific and technical equipment at the institutions. It enables you to examine, in a comprehensive manner, the quantity and quality of the equipment within individual institutions and departments, within certain geographical regions, and statewide.

It must be noted that certain qualifications are necessary before any final conclusions can be drawn from examining the data. The data are useful for determining where certain shortages exist, and what types of equipment are needed to upgrade the level of teaching or research at some institutions. However, because the response to the survey was not 100 percent, and because institutions did not indicate the degree of severity of their equipment needs, the data do not represent a complete picture as to why certain situations exist. The Board, therefore, will continue its examination of the equipment issue in cooperation with the colleges and universities which participated in the survey in order to develop a comprehensive analysis of the issue and identify potential solutions to the problem. We anticipate an opportunity to work with members and staff of the General Assembly in determining appropriate steps to increase the quantity and upgrade the quality of equipment in the institutions.

The data do reveal some significant findings which should be highlighted, and which merit your particular attention:

1. Meeting just the three to five highest priority equipment needs of the 374 responding departments at all levels (public and private colleges and universities as well as the community colleges) would require more than $35 million. In the UNC system alone (eleven responding institutions, 137 responding departments), meeting no more than 5 of the highest priority needs per department would require in excess of $23 million. The 185 departments in 53 responding community colleges have equipment needs (3–5 priority items) which require more than $6.7 million. It must be noted that this represents only a fraction of the priority needs of the institutions. Meeting all of their equipment needs at a reasonable level would require millions of additional dollars.

2. Very few of the high priority equipment items are currently on order, most likely due to inadequate funds to purchase new scientific equipment. For example, only about 2 percent of the high priority items needed by the community colleges are on order, according to the survey. If this situation is not altered—that is if the institutions are unable to obtain new equipment to upgrade their laboratories—the quality of research and education at North Carolina's colleges and universities will be adversely affected.

3. The mean age of all scientific and technical equipment in the institutions surveyed is 8.3 years. This is 1.3 years higher than the average age of equipment at 16 public and private research universities nationwide surveyed by the National Science Foundation. Significantly, the mean age of equipment at UNC-Chapel Hill, Duke, and N.C. State University—three of the state's premier research institutions—is 8.8 years. This indicates that, in the aggregate, North Carolina's prominent research institutions may be facing increased obsolesence with their equipment to a greater degree than similar institutions across the country. If the state is to maintain pre-eminence in scientific and technological advance, it must develop suitable methods for making state-of-the-art equipment and facilities accessible to its education and research institutions.

4. The data indicate that the greatest percentage of items of equipment were less than five years old (40 percent of all equipment). However, 94 percent of that equipment cost less than $5,000. Less than 1 percent of all equipment less than five years old cost greater than $50,000. (Note—51 percent of all equipment costing greater than $50,000 is less than 5 years of age). While colleges and universities frequently purchase new equipment, they appear to be unable to make frequent purchases of the more expensive equipment items. Laboratories which rely heavily on smaller, less expensive items may not, therefore, be facing obsolescence to the same degree as laboratories which require the more expensive, more sophisticated items.

5. The engineering disciplines indicated that approximately 11 percent of their equipment is more than 20 years of age, which is a much higher percentage than the other disciplines. The mean age of equipment in the engineering disciplines is also highest among all the disciplines.

6. As might be anticipated, nearly 85 percent of all equipment items are located in institutions in the Northwestern Piedmont and the Northeastern Piedmont. A number of factors contribute to the large concentration of equipment items in these regions, all of which should be taken into account in any analysis. The Board urges caution in reaching any conclusions based on these data.

7. For all institutions, the purchase of new equipment was rated higher priority than the maintenance of existing equipment. More than half of the departments of public institutions, it should be noted, rated purchase and maintenance of equal priority. On the whole, while institutions indicated that the maintenance of existing equipment was a serious ongoing problem, an even greater priority was placed on the purchases of new equipment.

8. Many institutions indicated a willingness to sell, share, or donate some of their equipment. Most institutions indicated that certain conditions would have to be met in order for such transactions to be satisfactory. For example, institutions indicated that their own staff and students must have first priority on the equipment, and that there must be assurances that the shared equipment would be used by properly trained personnel. Any maintenance problems that arise while the equipment is being shared would have to be promptly repaired at the user's expense, and any materials and supplies used would have to be paid for by the user. Donated equipment would have to be picked up by the receiving party, and all donated equipment being received would have to be functional.

A problem facing institutions of higher education in North Carolina and throughout the United States is chronological and technological obsolescence of scientific equipment used in teaching and/or research. Chronological obsolescence is related to age and wear, while technological obsolescence is related to the state-of-the-art of the equipment. Chronological obsolescence can occur when parts are no longer available, when cost of repair becomes prohibitive, or when the frequency of repair becomes unacceptably high. A point will eventually be reached where it is no longer worthwile to repair the piece of equipment.

Technological obsolescence is more difficult to define. Estimates of the age at which point technological obsolescence occurs range from 5 to 10 years. Technological obsolescence can occur when equipment is developed that has greater sensitivity and/or speed of operations. Some newly developed instruments have a 10,000-fold increase in speed and a 100-fold increase in sensitivity of measurement over similar instruments produced 10 years ago. Not all instruments, however, have had such a dramatic increase in sensitivity and speed of measurements, although this is the general trend in scientific equipment development. Increased sensitivity and speed of measurement produce more accurate results from a smaller sample in a shorter time period as compared to results produced using equipment 5–10 years old. The older equipment, therefore, can be considered as technologically obsolete.

The problem faced by the North Carolina institutions is a lack of access to the most recently developed equipment. Technological innovation has resulted in a much greater variety of equipment today than was available even 5 years ago. This equipment is essential to state-of-the-art research. The absence of this type of equipment may force researchers to produce data of marginal value. Some areas of research, such as surface chemistry, are not pursued in many institutions because the instrumentation required is not available at these campuses.

It is therefore clear that many of North Carolina's institutions possess equipment which may properly be labeled obsolete—by either of the above classifications. The data indicate that failure to take appropriate steps toward increasing the access of the state's institutions to more and better quality equipment will result in further exacerbation of the equipment problem. The data in this report provide a comprehensive contour "map" of the status of scientific equipment in the state, and should serve as a point of reference in fully analyzing the equipment problem.

The Board of Science and Technology will continue its study of the equipment needs of the state's institutions of higher education. The Board would appreciate an opportunity to pursue this effort in cooperation with the General Assembly. A great deal more analysis will be required to fully understand the nature of the problem and the types of solutions which might be recommended. The Board will move rigorously during the next several months to continue this effort, and will do so in conjunction with officials representing those institutions participating in this study. We would be pleased to prepare for you, at a later date, and in cooperation with your staffs, a more comprehensive analysis as well as a set of recommendations for addressing this issue.

We are grateful for the opportunity to work with you on this important effort.

Sincerely,

Quentin W. Lindsey,
Executive Director,
North Carolina Board of Science and Technology.

College of Arts and Sciences, University of North Carolina at Chapel Hill

SCIENTIFIC EQUIPMENT: INVENTORY AND NEEDS; NOVEMBER 1982

(Prepared by David H. Moreau, Associate Dean)

The purpose of this document is to report the inventory of scientific equipment in the College of Arts and Sciences and to estimate annual funding necessary to maintain our laboratories at a reasonable level of scientific capability. The document was prepared in response to a request from the Legislative Research Commission transmitted through the President of the University. Estimates reported here are based on two surveys of departments in the College. The first was undertaken in February, 1982 in which departments were requested to inventory all significant scientific equipment costing over $1,000 per item. That survey listed over 1,500 individual items. The second was based on the form supplied by UNC's General Administration entitled, "Equipment Profile: Sophisticated Scientific Equipment." On that form all departments were requested to list individual items costing over $10,000. Those forms were submitted to General Administration on April 9, 1982.

A summary and analysis of those results are shown in the attached table. The initial cost for all significant items costing over $1,000 is approximately $10.6 million while the inventory of items costing over $10,000 is $5.8 million. Thus, approximately half of the value of the inventory is in items costing between $1,000 to $10,000.

In the first survey we asked departments to indicate how much of their equipment was purchased with state funds and how much with non-state funds. With that information we estimate that appproximately one-half was purchased with state funds.

Of course those items cannot be replaced at their initial purchase price. Inflation has increased the average price of an item by 54 percent since its time of purchase, resulting in an estimated 1982 replacement cost of $16.4 million.

Our annual equipment needs consist of two parts. First, there is a need to replace worn out and obsolete equipment now in the inventory. The second part of that need is to acquire new kinds of equipment, items that we have been unable to purchase in the past, and new products which are becoming available on the market for the first time.

Depreciation rates on scientific equipment vary from field to field, depending on the rate of technological innovation. The estimated range for the College is 10 to 20 percent; the average rate, weighted by the value in each department is approximately 16 percent. Thus, at present prices, we estimate a replacement cost of $2.6 million per year. New product needs are estimated at approximately $900,000 a year over the next five years. The result is an estimated annual need of $3.5 million.

It is unlikely that under present Federal research funding that we will be able to maintain a non-State share of equipment cost of over 50 percent, but if that share could be maintained, our needs from state funds would be approximately $1.75 million per year. That figure is not unreasonable. With the special allocations for scientific equipment and instructional equipment over the past two years, totaling less than $600,000 per year, we have been able to address only the most pressing needs. Much of that money has gone to replace basic equipment that is more than 10 years old, some 20–30 years old. The scientific equipment money has been used in most cases to match federal grant money, thereby multiplying its effect on departments.

ATTACHMENT II

1983–85 Budget Request—Board of Governors of The University of North Carolina

PART 1, UNIVERSITY OPERATIONS—EXPANSIONS AND IMPROVEMENTS

Research and Teaching in Engineering and Science, Schedule of Priortities—Current Operations

Line 5—1983–84: $4,059,022; 1984–84: $4,059,652.

The request on Line 5 is for funds needed to correct deficiencies and to provide for needed expansions and improvements in programs in engineering and in some related programs in science in four consitituent institutions: North Carolina Agricultural and Technical State University, North Carolina State University at Raleigh, The University of North Carolina at Chapel Hill, and The University of North Carolina at Charlotte. The request continues and broadens in scope a major effort to improve programs in engineering and the sciences that was begun by the Board of Governors in 1979 with the high priority requests for equipment for the engineering and science laboratories at these four institutions. The importance of strengthening and expanding programs of teaching and research in the sciences and in engineering has been a national as well as a State Concern for some time. A recent editorial in Science (August 27, 1982) cites North Carolina's efforts as a model, and notes the importance of the relationship between education and research in these disciplines and the economic development of the State.

This request also responds directly to the findings and recommendations of a panel of consultants in a special study of engineering education made for the University during 1981–82. There are three schools of engineering in The University. The largest is at North Carolina State University at Raleigh, which offers 11 baccalaureate programs, nine master's, and eight doctoral programs. North Carolina A & T State University offers five programs at the baccalaureate level and three master's programs, and additional needed programs at both levels are being planned for the immediate future. The University of North Carolina at Charlotte offers three baccalaureate degree programs and one master's program in its College of Engineering. Each of these three engineering schools has its distinctive mission, and they

387

also have in common with on another and with engineering schools across the nation some serious problems. There are, in addition, specialized programs at the master's and doctoral level in environmental sciences and engineering and in biomedical engineering at the University of North Carolina at Chapel Hill. The only doctoral program in the University in computer science is also at this institution, and problems in that discipline are very similar to those in engineering. All of these programs, and the related graduate program in the physical, bioligical, and mathematical sciences at North Carolina State University at Raleigh and at The University of North Carolina at Chapel Hill are of great importance to the success of the Microelectronics Center of North Carolina and the entire course of the future economic development of the State.

Undergraduate enrollments in engineering have grown tremendously, while the output of Ph.D.s has fallen, and the schools are finding it difficult to attract and to retain faculty members. Technology and inflation have combined to create an additional set of major problems both for the engineering schools and the science laboratories. Equipment in the research and teaching laboratories is rapidly becoming obsolete in comparison to the research and development equipment in private industry, and the educational programs are feeling serious adverse effects. The panel of engineering consultants, after visiting the three schools, strongly recommended that laboratory equipment be improved and that additional resources be made available for maintenance of instructional and tesearch equipment.

The high costs of engineering education, and the difficult problems that the University faces in this area, have contributed to a decision by the Board not to establish any additional engineering schools. Doctoral study and advanced research in engineering will continue to be concentrated at North Carolina State University, and engineering clearly must be made an area of higher priority in the overall utilization of resources by the institution. It is also important that the work of the three engineering schools proceed in coordination with one another. Some research support, for example, is a critical element in faculty retention in all the schools and funds for cooperative research and training projects are therefore requested. Research professorships for The University of North Carolina at Charlotte and North Carolina A & T State University will enable these institutions to provide released time to members of their engineering faculty to pursue research activities, in cooperative arrangements with North Carolina State University. Similarly, as recommended by the engineering study, there is a need for the schools to work together in continuing education programs for the benefit of the engineering profession and of industry across the State and efforts are underway to expand cooperation in this area.

The problem of faculty salaries is not addressed in this Line, but it is a crucial one especially in engineering and in such disciplines as computer science. New baccalaureate graduates in engineering, for example, currently are receiving offers from industry for starting salaries comparable to the beginning salaries being offered to new faculty with the Ph.D. Substantially greater salary resources for the institutions, and greater support for faculty research and teaching are necessary if there is to be a solution to the increasing difficulty many engineering departments have in competing for both junior and senior faculty. Each of the three engineering schools is seeking greater help from industry through endowment and other funds to assist in resolving the salary problem, and the future of engineering education in North Carolina will depend in part on the support provided for faculty salaries and research by the major industrial employers of graduates of the engineering schools. To address another important recommendation from the engineering panel, it is proposed here that two Distinguished Professorships in Engineering be established at North Carolina State University in 1983-85 from State funds, to assist the school in its efforts to attract outstanding researchers to the campus and help to build the supportive environment that draws promising faculty and students.

Doctoral study in engineering and in certain critical scientific disciplines such as computer science is another area of need that is addressed in this request. The need to increase the production of doctorates in all of the engineering disciplines and in the natural sciences is an urgent requirement. Competitive doctoral study fellowships for U.S. citizens are of particular importance to the success of this endeavor, and funds are requested on behalf of each of the major research universities for this purpose.

	1983-84	1984-85
North Carolina A & T State University:		
Engineering laboratory equipment	$550,000	$550,000

	1983-84	1984-85
Laboratory equipment maintenance	$50,000	$50,000
Engineering faculty research support	50,000	50,000
Total	650,000	650,000
North Carolina State University at Raleigh:		
Engineering teaching laboratories equipment	900,000	900,000
Engineering research equipment	500,000	500,000
Laboratory equipment maintenance	100,000	100,000
Distinguished professorships in School of Engineering (2)	149,022	149,652
Doctoral fellowships in engineering	150,000	150,000
Total	1,799,022	1,799,652
The University of North Carolina at Chapel Hill:		
Science laboratory equipment	800,000	800,000
Laboratory equipment maintenance	60,000	60,000
Doctoral fellowships in sciences	150,000	150,000
Total	1,010,000	1,010,000
Engineering laboratory equipment	500,000	500,000
Laboratory equipment maintenance	50,000	50,000
Engineering faculty research support	50,000	50,000
Total	$600,000	$600,000

ATTACHMENT III

COLLEGE OF ARTS AND SCIENCES, THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL—SCIENTIFIC EQUIPMENT: INVENTORY AND NEEDS 1982

Department	Items over $10,000	Inventory of all significant items costing over $1,000				Estimated needs				
		State	Non-State	Total	Percent State	1982 Replacement cost	Annual depreciation rate	Annual replacement cost	New equipment needs (annual)	Total annual needs
Biology	557,738	752,640	844,770	1,597,410	47	2,706,257	11	297,688	159,700	457,388
Chemistry	2,983,414	1,968,283	2,701,240	4,669,523	42	7,091,631	20	1,418,326	252,375	1,670,701
Classics	46,110			46,110		70,000	10	7,000	2,000	9,000
Computer Sci	806,778	883,587	489,840	1,373,427		1,400,000	20	280,000	230,960	510,960
Dramatic Art	14,000			14,000		22,000	10	2,200	1,000	3,200
Geography	64,297			64,297		99,000	10	9,900	9,000	18,900
Geology	263,050	600,500	150,000	750,000	80	1,579,600	12	189,552	68,700	258,252
L Harris DC	73,343			73,343		110,000	10	11,000	2,000	13,000
Marine Sci	14,789	17,314	199,106	216,420	8	312,000	12	37,440	30,000	67,400
Music	61,444			61,444		95,000	10	9,500	1,000	10,500
Physics/Astr	712,105	543,803	982,408	1,526,211	36	2,440,000	12	292,800	97,000	389,800
Psychology	229,247	207,469	49,698	257,167	81	477,237	10	47,724	17,000	64,724

Mr. SIMON. Thank you very much for your testimony.

Dean E. Walter LeFevre, dean of engineering, University of Arkansas.

STATEMENT OF E. WALTER LeFEVRE, DEAN OF ENGINEERING, UNIVERSITY OF ARKANSAS

Mr. LEFEVRE. Thank you, Mr. Chairman. I am here representing the National Society of Professional Engineers as well as the University of Arkansas, and keeping with my constituents, my wife, who is a remedial elementary teacher, and my son-in-law, who is a junior high math teacher. That takes care of my constituents, and now I will proceed with my statement. [Laughter.]

You and the committee are to be commended for your efforts to address this very pressing problem, that of inadequate math and science education. The National Society of Professional Engineers shares these concerns fully. We are concerned about two groups of people, however—those who will use technology and those who must lead technology.

Those who will use the technology need to have a great familiarity with math and science. Those who are to lead technology, the engineers, must have a superior training in math and science. Although most of my remarks will be on part B, the postsecondary provisions, I would like to make some brief remarks, however, about part A.

Too much of the State higher education budgets are spent on remedial course work during the first year of college. Basic math, science, and communication skills, your foreign languages, must be developed at the local school level and then enhanced during college. The way we are doing it now, where we're having to do so much remediation, is simply economically unsound.

In the past, private industry has limited its involvement with the education community primarily at the postsecondary levels. As technology gains significance, the demand for a technically trained labor force is growing dramatically.

Now, NSPE, the National Society of Professional Engineers, believes that precollege education should primarily be a local government responsibility. We do, however, encourage private sector initiatives.

As an example, microcomputer manufacturers have determined that hands-on interaction with elementary and secondary students is a wise investment for them. There are many examples of private industry-public school programs in computer literacy for both students and teachers. The primary difficulty lies in the enormous magnitude of this and the resource limitations.

I would like, however, to talk to one of the ways that the National Society of Professional Engineers is meeting this responsibility. In conjunction with the National Council of Teachers of Mathematics and the CNA Insurance Companies, we are sponsoring a program called Mathcounts. The purposes of Mathcounts are to elevate the prestige of mathematics achievement among students, to increase awareness of the importance of mathematics, and to generate improvement in curricula. This is at the junior high level.

The National Society of Professional Engineers, particularly those of us in education, feel that the seventh and eighth grade mathematics problem is very severe, and we are not going to wait for the Federal Government, sir; we are going ahead. We would appreciate your cooperation, of course, and those Federal agencies, but it is too serious to wait any longer on it.

Mathcounts is just one of the new partnerships that are being forged in response to the widespread consensus, that cooperation between government, education, and industry is essential to this problem. It simply will not work for the Federal Government to do it all, because at some point the Federal Government must remove its funds and then the program ceases.

We feel not only should the Federal Government form partnerships with these outside communities, such as industry and education, but with each other. The National Science Foundation and the Department of Education should work very closely together. Both of them have important and complementary roles.

I would like now to address part B, the postsecondary education provisions. Section 621, concerning attracting students to the teaching provision, is a very noble one. I appreciate and support the aims of this program, but I hope you will consider alternative vehicles to accomplish the goals, such as those proposed in the earlier panel, from my colleagues in the higher education community, which would provide direct grants to colleges and universities for precollege teaching training programs.

In section 622, I strongly endorse the provisions of this section. But I would request that you add more specificity to the purposes of the grants. Engineering should be explicitly included with math and science improvement, and I also urge you to add a requirement for matching non-Federal funds. I know this is not in keeping with what you have heard from my colleagues in higher education, but I feel the partnership aspect is extremely important, that it must be the Federal Government, the local government, and industry involvement, as well as associations such as ours.

Section 625 is one that is extremely important, the one on equipment. I have submitted for the record a copy of our recent study, "Engineering Education Problems: The Laboratory Equipment Factor," which addresses the extent of obsolete instructional laboratories and facilities in our engineering schools. This was done solely by the National Society of Professional Engineers. It shows that the cost of modernizing just the engineering labs to take care of the 1981 enrollments is about $2.2 billion. It would be unwise for the Federal Government to put $2.2 billion in. It is a partnership effort. We are more concerned about the quality of our instruction and the quality of our product than we are of the quantity.

I commend the committee for their efforts and interest in this particular area. I feel like matching is very essential. We do recognize the responsibility of the Federal Government to insure that all students have equal access to quality education, and this has been a goal of the Department of Education for all of its life. We applaud them for the job they are doing and support the efforts of this bill to extend this principle to the issues that are being addressed today.

We feel that cost-shared programs are the most effective to solve these problems of math, science, and engineering education.

Thank you, sir.

[Prepared statement of Walter LeFevre and attachments follow:]

PREPARED STATEMENT OF THE NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

Mr. Chairman, Members of the Committee, I appreciate having the opportunity to comment this morning on H.R. 30. My name is E. Walter LeFevre, and I am here representing the National Society of Professional Engineers as a Vice President of that organization and chairman of the Professional Engineers in Education division. The National Society of Professional Engineers (NSPE) represents 80,000 members nationwide, including engineers in government, private practice, industry and construction, as well as in education. The Professional Engineers in Education division includes 3,000 professors and deans from all engineering disciplines.

I am also representing the University of Arkansas, where I am the Dean of Engineering. The University of Arkansas is the land-grant institution with five major campuses. The College of Engineering is located at Fayetteville with 2,300 engineering and engineering-related students. However, outreach activities to the 75 counties and 370 public school systems are a priority matter in the economic and technological health of the state.

Mr. Chairman, you and the committee are to be commended for your efforts to address one of our nation's most pressing problems, that of inadequate math and science education. I share your concerns fully, and would encourage you to include engineering education as an explicit component of both the problems you describe and the solutions you propose. While certainly it is imperative that the future users of technology, those young people not preparing for technical careers, have greater math, science and technical familiarity, it is equally essential that those students who are preparing for technical careers have superior skills. It is this group of students, the engineering students, who will be developing the technology upon which our nation's economic vitality and continued international competitiveness will depend. Thus I urge you, Mr. Chairman, and the Committee, to focus on both the future leaders, as well as the users, of technology in this session of Congress.

Though I will focus my remarks on Part B, the postsecondary provisions of H.R. 30, I would like to make brief remarks supporting your efforts to improve elementary and secondary math and science education.

Too much of the state higher education budget is spent on remedial coursework during the first year in college. Basic math, science, and communication skills must be developed at the local school level and then enhanced during college. To do otherwise is economically unsound.

In the past, private industry has limited its involvement with the education community to providing assistance to colleges and universities. As technology gains significance in all sectors of our society, the demand for a technically trained labor force is growing dramatically. Yet, as you know, our young people are shockingly illiterate in both math and science. Business leaders around the country are becoming increasingly concerned about the quality of elementary and secondary education. While NSPE believes precollege education should primarily be a local government responsibility, we encourage private sector initiatives.

Micro-computer manufacturers have determined that hands-on interaction with elementary and secondary students is a wise investment. There are examples of private industry-public school programs in computer literacy for students and teachers alike. The primary difficulty lies in the enormous magnitude of the situation and resource limitations.

I think everyone here today agrees that the issues we are discussing are multifaceted, and warrant a multifacted solution. We all recognize the no one group or piece of legislation can solve the plethora of problems we face. All of us have important roles to play. I would like to share with you one of the ways NSPE is meeting this responsibility. NSPE has committed itself to a cooperative project for our nation's junior high school mathematics students that we feel is particularly appropriate. The project, MATHCOUNTS, involves a partnership between NSPE and the CNA Insurance Companies, who currently have contributed $100,000. With the cooperation of other major organizations, we are sponsoring and developing a nationwide math contest for seventh and eighth graders, to be launched in September 1983. The purposes of MATHCOUNTS are to elevate the prestige of mathematics achievement among students, to increase awareness of the importance of mathematics, and to generate improvement in curricula. I have submitted detailed information for the record, and will be happy to answer any questions.

MATHCOUNTS is just one of many new partnerships that are being forged in response to the widespread consensus, both in Washington and around the country, that cooperations between government, education, and industry is essential. But while conferences, articles and even new associations recognize the need for external government cooperation, little attention has fallen on internal Federal activity. NSPE believes that government agencies should not only form partnerships with outside communities, but also with each other.

Mr. Chairman, the Department of Education and the National Science Foundation both have important and complementary roles to play, just as the education and the engineering communities do. I urge you to consider the importance of both agencies to successful upgrading of math, science, and engineering education.

I will now turn my attention to Part B of H.R. 30, the Postsecondary assistance provisions.

Sec. 621. Mr. Chairman, while we agree that something must be done to attract more students to the teaching profession, I am concerned that creating a new scholarship program such as that described in Sec. 621 is not the most efficient use of limited federal resources. As the committee knows, the federal government has a long and successful history of providing financial assistance for postsecondary education, yet in today's climate of fiscal austerity there is great pressure to decrease federal expenditures under these programs. Establishing another financial aid program would, I fear, divert limited funds from these most worthwhile programs. Further, other targeted scholarship programs to meet special needs exist. For example, the NSPE Educational Foundation awarded $354,000 to 134 high school seniors for engineering study during the 1982-83 academic year. We encourage other professional societies and industries to set up similar programs directed to their interests. The limited amount of scholarship that could be provided under section 621 will not have a substantial impact on current shortages of teachers but will require a substantial amount of administration. I appreciate and support the aims of this program, but hope you will consider alternative vehicles to accomplish your goals, such as those proposed by my collegues in the higher education community which would provide direct grants to colleges and universities for precollege teaching training programs.

Sec. 622. Mr. Chairman, I certainly endorse the provisions of this section. I would suggest that you add more specificity with respect to the purposes of the grants. Engineering should be explicitly included with math and science improvement, and I also urge you to add a requirement for matching non-Federal funds. Since activities funded under this section relate to the needs of industry, matching grants are particularly appropriate.

Sec. 623. NSPE supports the concept of summer institutes.

Sec. 624. NSPE encourages the investigation of effective methods of instruction, and endorses oversight by the National Institute of Education.

Sec. 625. Mr. Chairman, the problems you address here are of critical importance to the engineering profession. I have submitted for the record a copy of our recent study Engineering Education Problems: The Laboratory Equipment Factor, which documents the extent of obsolete instructional laboratories and facilities in our engineering schools. According to the study for laboratory equipment over the decade 1971-1981 should have been $580,900. Actual annual expenditures averaged only $152,600 per year for the decade. The cost of modernizing just engineering labs to accomodate 1981 enrollments is $2,195,417,000. We cannot afford to let our labs become even further antiquated. NSPE is more concerned about the quality, not quantity, of tomorrow's engineers.

I commend you, Mr. Chairman, and the Committee for your interest in this important area. From my experience, requiring a 2/3 non-Federal matching contribution is an appropriate response to the necessity for shared responsibility. However, we strongly believe that in programs directly related to science, technology and engineering activities, the proven expertise of the National Science Foundation in these areas should be utilized. Rather than placing the programs with DoEd, as in H.R. 30, I urge you to use the National Science Foundation for these purposes. Participants in the programs would greatly benefit from association with the expert research community of NSF. Further, NSF has a long standing history of involvement with basic research and is familiar with matters of laboratory equipment. NSF also works closely with the technology related industries that will be called upon to participate in the program. It seems clear that NSF is the appropriate agency to administer technical programs.

That is not to say that the Department of Education does not have a vital role. As I said before, both agencies are essential and complimentary in the contributions they can make in solving these problems. In particular, the Department of Education should continue to provide a base level of on-going support to maintain and improve the quality of education in our primary and secondary school classrooms. We also recognize the long standing and important responsibility of the Federal government to insure that all students have equal access to quality education. The Department of Education is to be applauded for the fine job it has done in this regard, and we support your efforts, Mr. Chairman, to extend this principle to the issues we are addressing today. This is especially relevant since not all schools have access to sufficient non-Federal resources needed to participate in programs that require cost-sharing. While we believe cost-shared programs are most essential to solve the problems of math, science and engineering education, broad-based programs at the primary and secondary school levels are necessary as well.

The Department of Education is the appropriate agency to administer those programs.

Thank you very much, Mr. Chairman, for the opportunity to testify here today. I will pleased to answer any questions.

Wilmington Delaware News, November 22, 1982

Adding up an answer ...

WHAT LIES BEHIND Japan's remarkable industrial and commercial accomplishments? That question has been baffling American business people, and they have come up with all kinds of answers. Among the more frequently heard are things like loyalty to one's employer; employers' paternalism for their employees; scrupulous attention to detail in the manufacturing process; a work ethic.

Now comes the latest study of the Japanese industrial system, this one done by William Freund, chief economist for the N. Y. Stock Exchange. Mr. Freund found that the "single most important factor" in Japan's high productivity lies in the high quality of primary and secondary education. Anyone familiar with the amount of time and effort Japanese children are expected to devote to their studies (in school and at home) and to the careful manner in which many Japanese parents supervise their children's studies will not be surprised by Mr. Freund's conclusion.

If American businessmen concur that a well-educated work force can be a crucial factor in improving productivity in today's technologically advanced work places that often include computers, robotics and other sophisticated production aids, what can — and will — they do to improve the depressed American educational system?

Education Secretary T. H. Bell has one good answer in mind for an area that is most fearfully neglected nationally: Promote instruction in mathematics by qualified mathematics teachers. The secretary has sent up trial balloons about federal funding for summer institutes to train teachers in the fields of mathematics and science — currently the two fields suffering from the most significant shortages. Secretary Bell believes that the necessary funds for this purpose can be shifted from a projected $500 million savings achieved by lower interest rates in the Guaranteed Student Loan program.

Congress will have to authorize this shift of resources, but it is hard to imagine that it would-not since there are already several bills dealing with the need to upgrade mathematics and science instruction before Congress. But the task of overcoming the current shortage of qualified math and science teachers should not fall completely on the public sector. N. Y. Stock Exchange Chairman William M. Batten says that the purpose of the Freund study was "to raise the awareness of American business leaders of their stake in improving primary and secondary education."

It has been customary for industry to be involved in the promotion of university education in those fields, but traditionally it has had little to do with primary and secondary education. But that's where the need begins, and that's where American education requires strengthening.

Business people can work with educators to help them develop appropriate curriculums; companies can "adopt" a school and send their personnel in to tutor students, hold workshops for teachers; teachers can be hired for meaningful summer jobs that enable them to enlarge their experience in the field they are teaching. Business can also urge Congress to adopt legislation helpful to education.

In Delaware, significant cooperative projects between business and the schools are in place. They include Junior Achievement, support for instruction in economics, the Jobs for Delaware Graduates programs, and more.

But in the specific areas of science and math more needs to be done, both to attract qualified teachers (right now, for instance, into the third month of the school year there are a couple of openings for math teachers) and to ensure that the curriculum is appropriate for the 1980s and beyond.

Delaware industry has been generous in lending its talents to aid the economic development in the state; now it should turn its attention to the underpinnings of the economy — the education of those who are expected to keep the economy humming.

Washington Post, August 8, 1982

Raise Academic Standards, Virginian Asks Governors

By Dan Balz
Washington Post Staff Writer

AFTON, Okla., Aug. 8—Warning that decisions made in junior high school can affect whether a student is likely to graduate from college, Virginia's secretary of education today called for political support for rigorous educational standards to end 15 years of "academic uncertainty" in the United States.

Appearing at the annual meeting of the National Governors Association, John T. Casteen III said high school students now tend to avoid rigorous mathematics and science courses and, without understanding the ramifications of such an approach, are thus determining what colleges, if any, will admit them and their eventual chances of graduating from college.

Casteen was part of a panel discussion on education for a high technology society. The group addressed the growing technological challenge from Japan and other nations and said that the United States must improve the technological skills of its citizens to compete successfully in a world economy increasingly dominated by electronics and computers.

Other panelists warned of the growing division among those in the United States who are technologically proficient and those who are not. The number of high school students taking advanced placement tests in math and science doubled during the 1970s, for example, while overall test scores for students in those subjects were declining.

"The danger is a society of two cultures," said Edward E. David Jr., president of Exxon Research and Engineering Co.

Casteen said that students who complete the most rigorous curriculum in high school are as well prepared as any students in the world today and probably better equipped than their predecessors.

But that accounts for only about 8 percent of all students, he said, adding, "After that, it drops off rapidly."

Casteen, who previously served as dean of undergraduate admissions at the University of Virginia, said students who do not take introductory algebra in the eighth grade virtually preclude their admission to the better colleges in their region. About four-fifths of all students do not elect to take beginning algebra in the eighth grade, he said.

Those who fail to take introductory algebra by the end of the ninth grade have put themselves on a track that makes it less likely they will graduate from college, even if they enroll in an algebra course after high school, Casteen said.

He also said it is increasingly difficult to find teachers for math and science courses, in part because opportunities in private industry are more attractive.

Casteen blamed these problems in part on 15 years of "academic uncertainty about schooling," adding that during that period fads "replaced . . . academic rigor" and there was a rapid loss of academic unity in universities.

"We have seen the assertion . . . that math and science are opposed to the liberal arts," he said. "That is not correct. Math and science are central to the liberal arts. Only in the last 15 years have we come to the conclusion that students can choose to be competent in math and science or in English [but not in both]."

Casteen called for political support for simpler standards of accreditation that focus on performance rather than "numbers of laboratories and doors." He said standards should be established that reward excellence rather than "inertia."

Basic education in this country is not the problem, Casteen said. "This is not an appeal to go back to basics," he said. "They aren't good enough." Instead he called for support for school curriculums in junior high school that help students build up their skills in increasingly complex areas.

The New York Times, Tuesday, December 28, 1982

ABOUT EDUCATION

Schools' Improvement Goes Unrewarded

By FRED M. HECHINGER

THE indicators of the public schools' academic achievement have risen dramatically in 1982, but the public still thinks the public schools are failing. The year about to end may well have been the schools' most successful in several decades, but at the same time, they face severe cutbacks in financial support from all sources — local, state and Federal.

The colleges, which have doubled their enrollments in the last 15 years and opened the doors to greater numbers of women and minorities than in any previous period, are reporting the first signs of economic barriers that may block the way to deserving but indigent candidates.

Such contradictory trends alarm many observers who, in recent years, have been exhorting the schools to toughen their standards and promising that such self-improvement would insure strong new public support. It now appears that even though the schools in many places have kept their side of the bargain, the rewards are lagging. In New York City, for example, fiscal austerity threatens to hit schools harder than other public services. In higher education nationwide, the elite colleges recently reported a reduction by more than a third in the number of students from low-income families in the last two years.

Harold L. Hodgkinson, a widely respected educational researcher, has published a list of impressive gains in educational quality in the December issue of the Phi Delta Kappan, a journal of education. He describes the 1970's as a period of "deep depression" in the people's faith in public institutions, but hopes the schools' improved performance will rebuild public confidence in them.

Mr. Hodgkinson, now a senior fellow at the Institute for Educational Leadership, was director of the National Institute of Education in the Ford Administration. His assessment of the schools' recent success points to the following indicators:

¶Since 1980, students' reading scores have showed significant increases in Atlanta, Boston, Chicago, Houston, Minneapolis, New Orleans, Newark, Philadelphia, New York City and other places. Other standardized tests also show that current elementary school children do better than their counterparts who were similarly tested in 1980.

¶Gaps in performance between blacks and whites, between formerly lower-achieving pupils in the Southwest and the East and West Coasts, and between rural and urban youngsters have narrowed considerably.

¶In 1970, only 58,000 high school students took advanced placement tests to show they had completed college-level work; in 1981, the number had more than doubled to 134,000.

¶Project Headstart, President Johnson's effort to give preschool children from poor homes the educational and psychological advantages routinely enjoyed by middle-class youngsters, has produced measurable results. The first Headstart group is now of high-school age, and a comparison with a control group of non-Headstart youngsters with comparable backgrounds shows significant differences. Headstart graduates who are now high school sophomores score one grade level higher in reading and mathematics. Only 19 percent of the Headstart group are in classes for slow learners, compared with 39 percent in the non-Headstart group. The $5,000 per child invested in Headstart, Mr. Hodgkinson says, may be saving $15,000 per child in subsequent remedial services.

¶Last year, the eight-member American team of high school students placed first among teams from 27 nations competing in the 22d International Mathematics Olympiad.

While there's no simple answer why the public schools have registered substantial improvements, experts cite a number of contributing factors. Outspoken and well-documented criticism of lagging efforts and low achievements put the schools and teachers on notice that more was expected of them. Stress on the basic skills became fashionable again at the very time when new research in the teaching of reading, writing and mathematics made it possible to teach more effectively.

Rediscovery of the importance of strong leadership led to the appointment of able superintendents and principals. Many teachers worked harder at improving their skills by volunteering for attendance in after-school teacher centers, many of them originally subsidized by the government. Parents and community leaders concentrated on the improvement of school discipline and attendance. The ideological rhetoric that used to downgrade academic standards and requirements has given way to concern over educational performance. Many pupils, worried about their future at a time of recession, are giving their studies a higher priority.

●

In view of such measurable progress, many observers are dismayed over the slow and often still hostile response from the public, and particularly from government at all levels, to the schools' needs. The elimination of many specific Federal aid programs originally earmarked to improve the education of disadvantaged youngsters, and the submersion of such dollars into the grab-bag of general aid or block grants, is seen not only as a retreat from equal opportunity but as a new threat to educational quality.

No real solutions have been found to the critical shortage of mathematics and science teachers as business and industry gobble up the available talent at higher salaries. Mr. Hodgkinson sees hope in a renewed interest shown by industry in support of the public schools, and there have indeed been some favorable signs, as in the more than 200 adopt-a-school programs in which corporations provide financial and personnel aid.

Still, the chances are slim that recent gains can be maintained and built into a long-term educational revival, or that access to higher education can remain open without regard to economic status, unless public and legislative attitudes catch up with the new and promising educational realities before the gains are eroded and the system goes into full-scale retreat.

... THE TIME HAS COME FOR MATHCOUNTS ...

Chicago Sun-Times, Tuesday, December 28, 1982

Math-science crisis

America's heavy industries will never recover completely from the recession, and many of their low-skilled unemployed workers will never get their old jobs back.

Our economic future lies in computers, robotics, biogenetics and other highly technical fields that require workers trained in science and mathematics.

But where will those workers come from? The nation's schools are totally unprepared to meet the need.

Only one-third of the nation's school districts require more than one year of high school science and one of math. Only 10 percent of high school students take physics. A Japanese or Russian high school student takes two to three times as much math and science as an American student.

At the core of the problem is the shortage of qualified teachers. According to the National Science Teachers Association, 43 states say they are short of math teachers and 42 are short of physics teachers.

The average university, according to the association, has only four students learning to teach math and seven preparing to teach science. None of the University of Minnesota's 59,000 students majored in math education this year and only one graduated in science education.

And why *would* any science student enter high school teaching at a starting salary in the $15,000 range, when private industry pays around $27,000? As many as 25 percent of those who now teach science or math plan to jump to industry, the science teachers' group says.

The solution is obvious. Every other industry pays higher salaries to employees whose skills are in the greatest demand; the public schools must, too. According to the Wall Street Journal, science and math teachers already get a pay bonus in Houston, Oklahoma City and Richmond, Va.

Those cities admittedly have weak or nonexistent teachers unions. Unions have fought pay differentials with a vengeance, but they'll simply have to stop. Taxpayers cannot afford to raise all teacher salaries to the level necessary to attract and keep the ones who teach science and math.

But the alternative—paying modest wages to all teachers—will ensure that the nation never will have enough scientifically skilled workers to compete with foreign industry. We certainly can't afford that.

. . . and Chicago's dismal example

We don't have to look far for an example of this country's glaring failure to train young people in science and mathematics.

There is, unfortunately, the Chicago public school system.

It has only one physics teacher for every two high schools, and most of them teach physics only part-time. A number of high schools have dropped chemistry, physics and advanced math entirely.

Frances S. Vandervoort, one of the surviving Chicago high school science teachers, proposed some sound remedies a few months ago in a Personal View.

Business and civic leaders should pressure the School Board to put more resources into science and math teaching, with up-to-date methods. And parents should prod children to pick these courses instead of easy ones with no homework (and no future application).

But those efforts will be pointless if the school system doesn't have qualified teachers. That leads us back to the problem we discussed above: the need to offer premium pay to teachers of special skill and training.

Is there any point in even suggesting this to a teachers union wedded to archaic, unaffordable practices, an easily intimidated School Board and a mayor who refuses to think about next year's bills?

THE CNA INSURANCE COMPANIES

The CNA Insurance Companies, headquartered in Chicago, is one of the nation's largest insurance organizations. It provides all-lines insurance coverage for individuals, businesses, groups and associations in 50 states, and has close affiliations with insurance groups in Great Britain, Switzerland, Japan, Puerto Rico and the Caribbean.

CNA operates through its home office, 33 branches and more than 70 other field locations. Although comprised of several companies, CNA is a single business entity, marketing its consumer-oriented insurance products through independent agents.

CNA Financial Corporation, with more than $9 billion in assets, is the parent company of the CNA Insurance Companies. The majority of CNA Financial stock is held by the Loews Corporation headquartered in New York. Subsidiaries of CNA Financial include General Finance Corporation, American Casualty, CNA Casualty of Puerto Rico, Continental Assurance, Continental Casualty, Modern America, National Fire Insurance Company of Hartford, Transportation Insurance and Valley Forge Life Insurance Company.

CNA is committed to meeting the entire range of consumers' insurance needs and being the single source of insurance for an ever-growing percentage of people. In its achievement of these goals CNA places importance on its role as community citizen in the name of its employees. Its programs have expanded, reflecting the company's desire to respond positively to community needs.

CNA aids minorities by funding agencies and organizations which promote legislative equality and improve housing, school and other city and community conditions.

In health matters CNA funds a variety of public programs and agencies devoted to health protection and maintenance. The company has responded to mental and physical rehabilitation projects, as well as programs for hospice in the home.

One of the most exciting programs recently developed by the company uses the arts - music, theater, dance and visual stimuli - as communication tools in the classrooms of Chicago's inner city schools. Through performances and workshops for elementary and high school students, CNA and arts groups work with teachers of math, language, arts, history, music and drama to relate the arts to classroom subjects and improve comprehension and retention of basic curriculum.

CNA meets community youth concerns by aiding local youth centers, urban leagues, boys' and girls' clubs and educational projects. It has adopted a public school for the multiply handicapped in Chicago, and personnel work closely with school officials in the implementation of training programs for blind and visually-impaired students, and counseling in insurance-related careers for the school's classical component.

CNA's greatest single philanthropic commitment is improving math literacy among elementary and high school students. Currently the company sponsors the country's largest statewide high school math contest, the ICTM Math Contest, created by the Illinois Council of Teachers of Mathematics. Each year thousands of the state's best math students compete for scholarships, calculators and trophies in college-level regional and final competitions. The company anticipates this contest will foster a greater interest in professional math careers for students.

CNA also sponsors a special math program with the Chicago Urban League in Chicago's inner city public high schools. The program promotes math excellence through tutoring and competitive practice, so that talented math students are able to compete in the ICTM contest and can take advantage of accelerated math courses available in the city.

CNA's collaborative effort in this national math contest, MATHCOUNTS, further indicates the company's concern for the nation's technological future, and its continued interest in better math programs for students at ages where career guidance is essential. Because MATHCOUNTS is an immediate response to math illiteracy, CNA is pleased to be a part of this national effort which will influence and encourage millions of students to become more responsive to math and its related career opportunities.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

NSPE

OFFICE OF THE
EXECUTIVE DIRECTOR

January 7, 1983

Dr. Edward A. Knapp
Director
National Science Foundation
Room 520
1800 G Street, N.W.
Washington, D.C. 20550

Dear Dr. Knapp:

The purpose of this letter is to request the participation of the National Science Foundation in a broad-based mathematics education project which addresses a problem of critical national importance.

While it is clear that basic math, science and computer familiarity are essential to participation in our technologically advanced society, our educational system is not currently providing as strong a foundation in these areas as is necessary to insure a technically literate population. A major weakness of particular concern to the engineering profession is mathematics and science achievements of precollege age students. To meet that concern, the National Society of Professional Engineers in cooperation with the CNA Insurance Companies of Chicago, has made a firm commitment to conduct a national mathematics contest for students in grades seven and eight titled MATHCOUNTS. MATHCOUNTS is a unique approach to a critical national problem and no comparable program for grades seven and eight is either planned or in operation. MATHCOUNTS has three main objectives:

- To elevate the prestige of achievement in mathematics among students in grades seven and eight
- To increase awareness of the importance of mathematics among parents, educators, and the general public
- To bring about improvement in mathematics curricula and instruction in grades seven and eight

MATHCOUNTS will be conducted on four levels utilizing several contest modes. It will stress both individual and team competencies utilizing progressively more difficult mathematical concepts and applications. Three of the four levels of competition parallel the permanent structure of NSPE's 535 local chapters, 54 state and territorial societies and national level organization. The fourth level is an intra-school competition that is conducted apart from the more formal chapter, state and national contests. At the intra-school level, teachers will have the opportunity to generate interest and to select the best candidates for the teams that compete in the "chapter level" contest. The entire program is being developed to encourage full student participation and will involve business, industry, and professional entities at all levels. Attractive awards will be made to individuals, schools, teams and coaches at each level. The competitions will be designed for audience appeal so that maximum public interest may be generated.

MATHCOUNTS is being developed and implemented with the assistance and cooperation of the National Council of Teachers of Mathematics, (NCTM) the Mathematics Association of America (MAA) and the National School Boards Association (NSBA). Other organizations from whom professional support and input are being solicited are the National Association of Secondary School Administrators, National Council of Mathematics Education Supervisors, and the National Science Board's Commission on Precollege Education in Mathematics, Science and Technology. The Program has also been discussed with and received strong support from other science, engineering and education groups including the American Association for the Advancement of Science.

The design and conduct of MATHCOUNTS is being guided by a Task Force and a Working Group, both of which are comprised of representatives of the involved organizations. A schedule of critical events for the Task Force and Working Group and a preliminary budget are attached for information. Excellent progress has been made to this point and we are now turning to funding the "start-up" phase of MATHCOUNTS which includes items I, II, and III of the preliminary budget with a total estimated direct cost of $361,000. That will take us through the initial competition cycle now scheduled for 1983-84.

Once the first competition cycle (school, chapter, state, national) has been completed, we expect the program will become essentially self supporting through contributions of money and/or volunteer effort from CNA, local businesses and industry, the National Council for Teachers of Mathematics and NSPE. CNA has already made a firm commitment of $100,000 to help cover expenses for 1982 and 1983. NSPE and NCTM will provide the personnel to organize and conduct the chapter, state and national level competitions including obtaining contributions to cover the direct dollar costs of conducting those competitions. However, for this start-up cycle, we do not anticipate having arrangements in place to cover the entire $361,000 which includes the initial awards inventory and contest materials and support for the first round of competition.

MATHCOUNTS is in keeping with President Reagan's emphasis on private sector initiatives to deal with national problems. It will eventually be fully sustained by private sector resources. In keeping with an appropriate governmental role for such undertakings, we seek only modest federal funds to assist in the start-up phase. More importantly, we seek the formal endorsement of NSF for this vitally important program.

Therefore, we invite the National Science Foundation to become a full sponsor of MATHCOUNTS. Additionally, we request a one-time grant of $200,000 to cover the anticipated shortfall in the start-up expenses. A copy of the MATHCOUNTS Organization Booklet and a brochure that describe many details of MATHCOUNTS are attached to provide additional information to assist you in your evaluation of this request.

I urge the National Science Foundation to join with the National Society of Professional Engineers and CNA in making MATHCOUNTS available to the America's seventh and eighth grade students. At your earliest convenience, representatives of NSPE and CNA would like to meet with you and appropriate members of your staff to discuss the MATHCOUNTS program. We plan the first public announcement about MATHCOUNTS during National Engineers Week, February 20-25, 1983. We feel that the announcement will have greatest effect if the NSF is identified as a full sponsor.

Sincerely,

Donald G. Weinert

Donald G. Weinert, P.E.
Executive Director

DGW:gl

Encl.

cc: Dr. Donald Langenberg
Dr. Gillespie
Dr. Nicholson
Dr. Sanderson
Dr. Hall

PRELIMINARY BUDGET
(First Two Years of Activity)

I. START-UP PHASE

Printing-Bulletin Board Posters (100,000 at .09)	$ 9,000	
Printing-Brochures (100,000 at .14)	14,000	
Printing-Competition Instructions (15,000 at .25)	3,750	
Art Work/Typeset/etc.	5,000	
Postage	15,000	
Printing-Miscellaneous	5,000	
Printing-Tests	10,000	
Advertisements	1,500	
Long Distance Telephone	2,000	
Staff Travel	3,000	
Committee Travel and Meeting Expenses	10,000	
Miscellaneous Items	1,000	
		$ 79,250

II. AWARDS INVENTORY

Art/Design	$ 2,000	
Engraving Trophies (National Level Only)	3,000	
Printing Certificates (15,000 at .31)	4,650	
Trophies (State Winners and Runner Ups)(3,600 items at $7)	25,200	
Trophies (National Winners and Runner Ups)(1,200 items at $10)	12,000	
Packaging Materials	2,100	
Postage	3,000	
		$ 51,950

III. CONDUCTING COMPETITIONS

Initial		
Test Expense	$10,000	
Intrastate		
Room Use Contingency	$ 5,000	
Transportation Contingency	10,000	
Janatorial Contingency	5,000	
Liability Insurance	1,000	
State		
Hall Rental Contingency	$10,000	
Transportation Contingency	20,000	
Janitorial Contingency	10,000	
Liability Insurance	3,000	
National		
Hall Rental	$ 5,000	
Transportation (4 persons per state X 50 states X ($500 air + $150 Hotel and meals	130,000	
Entertainment/tours	5,000	
Awards Banquet (500 persons X $20 each)	10,000	
Equipment Rental	2,000	
Miscellaneous	5,000	
		$230,000
GRAND TOTAL		$361,200

SCHEDULE OF CRITICAL EVENTS - MATHCOUNTS WORKING GROUP

1. September 15, 1982 - Identification of working group members.
2. October 1982 - First working group meeting (develop detailed work schedule).
3. October 1982 - (same date) - Letterhead stationery for Project "MATHCOUNTS" available and promotional brochure developed.
4. January 1983 - Second meeting of working group - development of program details and materials.
5. May 1983 -Third meeting of working group - continue development of program materials.
6. August 1983 - Produce initial supply of program materials.
7. September 1983 National press conference in Washington,D.C. announcing program.
8. October 1983 - Administer initial test.
9. February 1984 - (Engineers Week) - Chapter level Intrastate competitions.
10. April 1984 - State level competitions.
11. May 18-19 1984 - First annual National MATHCOUNTS competition, Washington, D.C.

.39- 11 pages

([illegible] Copy)

NATIONAL TASK FORCE
MATHCOUNTS

MATHCOUNTS ORIENTATION FOR
NSPE STATE SOCIETIES AND CHAPTERS

PREFACE

Mathematics achievement levels of precollege students directly affect the engineering and scientific professions. The NSPE has considered the many factors impinging upon precollege mathematics achievement and has focused its attention on: (1) the motivation of students to seriously study mathematics and (2) the level of prestige among students and the general population attached to achievement in mathematics. Without the motivation to achieve competency in mathematics and the reinforcement derived from peer and public recognition of mathematics competency, students will be tempted to pursue competing options that require less concerted effort for success. The NSPE has selected a mathematics contest - MATHCOUNTS - as a means of providing both motivation and reinforcement for students and has identified grades seven and eight as the most appropriate targets for the competition. MATHCOUNTS is compatible with the TEAMS contest that is conducted by the Junior Engineering Technical Society (JETS) for high school students.

If the mathematics competency of more students in grades seven and eight is elevated, the number of high school graduates who are competent in mathematics and science can be expected to increase. It is reasonable to expect that some of these better qualified graduates will study engineering thereby strengthening the profession.

The NSPE has been joined by the CNA Insurance Companies in sponsoring the MATHCOUNTS competition. This cooperation will enable MATHCOUNTS to become a reality during the last quarter of 1983 and the first half of 1984. The National Council of Teachers of Mathematics, Mathematics Association of America, Junior Engineering Technical Society, and the National Association of School Boards have also joined with the NSPE and CNA to make MATHCOUNTS a national success in impacting the mathematics literacy of the country's youth.

A cooperative project of the National Society of Professional Engineers, the National Council of Teachers of Mathematics and the CNA Insurance Companies

MATHCOUNTS will be conducted in the three-level format (chapter, state society, national society) that has made other NSPE programs successful. Every effort is being made to make MATHCOUNTS logistically efficient at all three levels particularly for the participating schools.

OBJECTIVES

The objectives of MATHCOUNTS are:

- To elevate the prestige of achievement in mathematics among students in grades seven and eight
- To increase awareness of the importance of mathematics among parents, educators, and the general public
- To bring about improvements in mathematics curricula in grades seven and eight throughout the United States

ORGANIZATIONAL STRUCTURE

The organizational structure of MATHCOUNTS will be based upon the NSPE tripartite schema but will interface with the school system patterns, the CNA Insurance Companies network, and the National Council of Teachers of Mathematics regional councils.

Geographic

Competitions will occur on the following geographic bases:

- School level
- NSPE Chapter level
- NSPE State Society level
- National level

Schools

Individual schools will be provided with descriptive materials for MATHCOUNTS, but the intra-school competition format will be left to the school's discretion. The objective of the school format will be to identify a team of four (4) students and a coach who will work together to prepare for the NSPE Chapter Level (regional) competition. The students on the team must be enrolled in grade seven (7) or eight (8), mixed or unmixed as the coach sees fit. Students on a team should be from the same school but several schools by mutual agreement may field a joint team. For example, a school district with six schools that have grades seven or eight will be entitled to enter only one team from each school which has a seventh or eighth grade.

NSPE Chapter Level

A standardized competition using questions and format supplied by national MATHCOUNTS will be conducted by NSPE Chapters for schools within their chapter areas at the discretion of the Chapter. Chapters within a state will not be eligible to participate unless the State Society also agrees to sponsor a state competition. One (1) team from each school within the Chapter's area will be eligible to participate in the Chapter Level competition. The Chapter will have the option of "fielding" one, two, or three teams for the State Level competition.

Chapters will select a winning TEAM and a minimum of three "place" winners (maximum number of place winners to equal not more than 5% of the total number of participating teams). In addition, The Chapter will select a winning INDIVIDUAL and four (4) individual place winners up to a maximum of twelve (12) individual place winners. Distinctive trophies will be provided to the members, coach, and school of the winning TEAM and place winners. Distinctive trophies will be provided to the winning INDIVIDUAL and place winners of each chapter. All Chapter Level participants will receive a "Certificate of Merit" for their efforts. Certificates will be furnished free and trophies at cost by NSPE.

NSPE State Level

A maximum of three (3) teams from each chapter in a state will be permitted to enter the State Level competition, as determined by the state. A standardized competition using questions and format supplied by national MATHCOUNTS will be conducted by NSPE State Societies who elect to do so. State Societies who elect not to conduct a State MATHCOUNTS competition will automatically exclude all chapters in their state from participating in the program.

States will select one TEAM winner plus four team place winners. In addition, one INDIVIDUAL winner plus from one to eight individual place winners will be selected (at the discretion of the State Society). Appropriate trophies will be presented to the team members, coaches, and schools of all winning and placing TEAMS. Distinctive trophies will be provided to the winning INDIVIDUAL and place winners in the State Level competition. All State Level participants will also receive a commemorative medallion in recognition of their efforts and mathematical achievements. Medallions and trophies will be provided at cost by NSPE

National Level MATHCOUNTS

One team comprised of the four highest scoring individuals in the State Level competition and the coach of the State Team Winner will represent the state in the National Level competition. The National Level competition will consist of exercises that parallel those of the State and Chapter Levels.

National competition winners will consist of a TEAM winner and five (5) team place winners. In addition, an INDIVIDUAL winner and eight (8) individual place winners will be selected. A special category INDIVIDUAL winner and two (2) individual place winners will be selected for the "Special Topics" competition. Special trophies will be awarded to all "winners" and "placers" in the teams, individual, and special topics competitions. Schools of all team winners and placers will also receive a trophy.

COMPETITION COMPONENTS

The competitions at the Chapter, State, and National levels consist of the same format. Questions will become increasingly difficult as the competition progresses towards the National level. Some of the competitions yield both individual and team scores while others yield only one type of score. The following matrix illustrates all aspects of the competitions:

TYPE OF QUESTIONS	COMPETITION LEVELS	YIELD SCORES FOR	DURATION IN MINUTES
Written	Chapter State National	Individuals and Teams	Approx. 40
Individual Solutions	Chapter State National	Individuals and Teams	Approx. 20
Team Solutions	Chapter State National	Teams	Approx. 20
Topic Written	Chapter State National	Individuals and Teams	Approx. 30
Topic Oral	Chapter State National	Individuals	Announced each year

The written examination will consist of approximately 40 questions that are distributed to the competitors all at the same time with time being such that only the most capable persons will complete all of the items.

Individual Solutions is also a written exercise except that the questions are distributed one at a time, and each question has a time limit. A running score-board will track the team and individual scores as each question is completed.

Team Solutions is an activity wherein the entire team works together to devise the answer to a fairly difficult and involved problem. Hence, only a team score is yielded.

Topic-Written is a specially designed component of the competition wherein MATHCOUNTS announces the special topic for the year's competition and distributes references and descriptive materials. Coaches, students, and others work to prepare the competitors on the specific topic. Examples of special topics are Markov Chains, statistics, and other concepts that enable the competitors to master the material and to apply it creatively. The same topic will be used in the Chapter, State, and National competitions in any given competition cycle.

Topic-Oral is a special competition in which the top ten individual scorers will be asked to respond verbally to questions that are presented by a panel of judges. The topic will be the same as for the Topic-Written competition but will value creativity and verbal expression as well as mathematical accuracy. A special category of "winner" and two placers will receive appropriate trophies as a result of this competition.

At all levels of competition, in is important to employ techniques and devices that make the competitions dynamic and interesting to the public. The MATHCOUNTS COMPETITION HANDBOOK contains ideas on how to accomplish this.

Calculators, slide rules, books, computers, etc. are not allowed to be used during the competition sessions.

CONTEST CONTENT

The following topics will serve as the basis for question preparation in the Written and in the Individual and Team Solution Competitions at the Chapter, State, and National Levels:

Estimation/approximation

Computation - wholes, integers, rationals, roots, percentage, average, exponents, proportion

Statistics - means, median, mode, projections on given data, min/max range

Probability - simple events, combinations, permutations, counting properties

Measurement - linear, area, volume, conversions within system, temperature, time

Geometry - parallel lines, perpendicular lines

Charts, Graphs, Tables - interpreting and applying Cortesian coordinates

Number Theory - patterns, primes and composites, prime factorization, LCM, GCF, modular arithmetic divisibility

Scientific Notation

Equations/Inequalities

Consumer Math

Algebra Topics - order of operations, simplifying expressions

Field Properties

Numeration Systems - non-decimal bases

FINANCIAL FACTORS FOR CHAPTERS AND STATE SOCIETIES

NSPE will purchase a supply of trophies and other recognition devices that is sufficient to meet the needs of all participating states and chapters. These specially designed MATHCOUNTS items will be furnished to the state societies and chapters at cost in accordance with their needs.

All MATHCOUNTS tests will be produced by NSPE and furnished to the states and chapters at cost

Other incidental items will be produced by NSPE and furnished to the states and chapters at cost.

Each participating chapter will be responsible for working out the transportation and other administrative details with the participating schools in their chapter area. Promotional and contest materials (except trophies and medallions) will be provided by NSPE at no cost. All other costs associated with the conduct of the Chapter Level competition are the responsibility of the Chapter. Transportation of the team(s) from the Chapter to the State Level competition is also the responsibility of the chapter.

Each participating state society will be responsible for all costs associated with the conduct of the State Level competition and board of the State Team at the National Level competition. Transportation to the national competition for four students and one coach from each participating state will be provided by the national MATHCOUNTS.

The National Level competition will be the responsibility of the NSPE and the CNA Insurance Companies.

The nature of MATHCOUNTS makes it an appealing program to local businesses and industries as well as civic and social organizations. It is anticipated that the chapter and state organizations will utilize the appeal of MATHCOUNTS to secure financial support for conducting MATHCOUNTS in their chapter area and state.

As a guide for computing estimated costs for trophies at each level, the following information has been compiled:

SCHOOL COMPETITION - national provides MATHCOUNTS manual, certificates of participation, and ribbons for winners

CHAPTER LEVEL COMPETITION - Certificates of merit for all participatns obtained from NSPE.
4 to 12 individual trophies per chapter at $11 each. 3 to (5% of participating teams) X 5 persons per team + a school trophy = 3 X 6 X $11 each

STATE LEVEL COMPETITION - 4 to 12 individual trophies X $15 each. 3 teams max. per chapter X $5 per medallion X 5 persons per team. 3 to (10% of participating teams) X 6 trophies per team X $15 each

NATIONAL LEVEL COMPETITION - All awards provided by NSPE and the CNA Insurance Companies

Note that the chapters and states have control of the options on how many trophies to award and, in the case of the chapters, how many teams to send to the State Level competition (maximum of three teams from a single chapter).

MATHCOUNTS SCHEDULE FOR 1983-84

September 1983 - National press conference in Washington, D. C. to open the competition

September 1983 - Schools begin shaping and selecting their team(s)

February 1984 - During Engineers Week, conduct the Chapter Level Competition

April 1984 - State Level Competition is conducted

May 18-19, 1984 - First Annual National MATHCOUNTS Competition is conducted in Washington, D. C.

Between January 1983 and May 1, 1983, the state societies and chapters will decide whether or not to participate and will make contact with the schools to promote participation in MATHCOUNTS. If your state society has already decided to conduct MATHCOUNTS, please complete and return the response form located at the end of this orientation so that your state can be included in the program announcement during 1983 Engineers Week. By May 15, 1983, the MATHCOUNTS COMPETITION HANDBOOK will be available at no cost to the schools, chapters, and state societies who are participating in MATHCOUNTS.

LAUNCHING MATHCOUNTS

NSPE will send a questionnaire to each State President and State Society Executive early in February 1983 to determine whether or not the state will participate in MATHCOUNTS during the 1983-84 program. If a state society indicates that it will participate, specific arrangements will be worked out with the state for ordering materials, etc. Contact with chapters will be the responsibility of the participating state societies. National will interact with chapters only after being given clearance by the state society.

PROGRAM STAFF

MATHCOUNTS will be provided with staff support by the NSPE Education Services Department, (202) 463-2331.

SUMMARY

The following summary of MATHCOUNTS competition materials is applicable only to state societies and chapters that are conducting the MATHCOUNTS competitions:

Item	Cost to State/Chapter
MATHCOUNTS "T" Shirts	At Cost
MATHCOUNTS Competition Questions	Free
MATHCOUNTS Scoreboard	Free
MATHCOUNTS COMPETITION HANDBOOK	Free
MATHCOUNTS Promotional Materials	Free
MATHCOUNTS Ribbons for School Winners	Free
MATHCOUNTS Certificates for School Level Participants	Free
MATHCOUNTS Certificates for Chapter Level Participants	Free
MATHCOUNTS Trophies for Chapter Winners/Places	At Cost
MATHCOUNTS Medallions for State Competitors	At Cost
MATHCOUNTS Trophies for State Winners/Places	At Cost
Transportation to National Competition for 1 team per participating state	Provided by National MATHCOUNTS

YES, the ______________________ Society of Professional Engineers will participate in the 1983-84 MATHCOUNTS competition.

____
State Society President

____
Date

Please return this immediately to:

Joseph M. Snarponis, Director
Education Services Department
NSPE
2029 K Street, NW
Washington, D. C. 20006

Mr. SIMON. Thank you.

Since I am alone up here right now, let me just take the liberty to toss questions at members of the panel as we proceed.

Your field, Dean, is one that is used as an example by those who oppose any bill at all. They say, at one point we had a shortage of engineers and we ended up with a surplus and now we are moving back into the shortage period. You simply let the marketplace take care of things and the Federal Government shouldn't be getting into this thing at all.

How do you respond to that?

Mr. LEFEVRE. I think we have been ill-advised in the past to talk about shortages and surpluses when what we should have been addressing was the quality of our program. So in that regard I would say the quality of our program is one that involves all three groups. If we talk about shortages and surpluses, the marketplace will take care of that. I think we have spent way too much time talking numbers; we need to talk quality.

Mr. SIMON. That's an excellent answer. Thank you. I'll probably use that answer and never give you a bit of credit. [Laughter.]

Dean Charles Ruch, dean, school of education, Virginia Commonwealth University.

STATEMENT OF CHARLES RUCH, DEAN, SCHOOL OF EDUCATION, VIRGINIA COMMONWEALTH UNIVERSITY

Dr. RUCH. Thank you, Mr. Chairman. I appreciate the opportunity to appear before you and to offer testimony on behalf of H.R. 30. I am here representing the American Association of Colleges for Teacher Education. AACTE is a national professional organization of colleges and universities dedicated to teacher preparation and renewal. Collectively, our member institutions prepare over 80 percent of all new teachers annually.

Your attention is well directed to search for solutions to shortages of qualified math and science teachers. The shortages are real and they are exacting a national toll. As you have heard here today, the shortages involve not only teachers in this area but scientists, engineers, and in fact cut across the entire educational program.

I feel obliged to comment that the shortages of qualified teachers are not limited to scientific disciplines. There are shortages of qualified personnel in many subjects, in many geographic areas. A recent summary of characteristics and attitudes of the entering freshman class of 1982 revealed that only 4.7 percent of that population planned either to become elementary or secondary schoolteachers. If this is correct, shortages will multiply in the years to the current potential shortages without a significant Federal, State and local effort to recruit teachers for classroom positions and to encourage them to remain in the profession.

The introduction of H.R. 30 is an important step. However, because the public expectations are now very high, and because economic realities dictate that Federal investment will, of necessity, be modest, I believe it is important, that your deliberations result in legislation that school districts and institutions of higher education can use as a workable model to execute needed changes and as a model that can address current and future shortages as they occur in the future years. I believe this legislation goes a long way toward that goal, but we would like to express several structural concerns that might impede its successful implementation. Without altering the inherent principles of the legislation, I believe some of these obstacles might easily be removed:

Parts A and B seem to exist in different worlds. No solution to this complex problem can succeed unless all segments of the educational enterprise work in concert. For example, section 603 allocates funds to local school districts for a series of activities designed to upgrade the skills of teachers and administrative personnel as described in section 604. Use of community resources, including colleges and universities, is encouraged. But many colleges and universities are not prepared to deliver that kind of inservice that schools and districts need, expect, and deserve.

For example, in recent years the number of institutions of higher education offering mathematics and science training has declined. Only about 40 percent of all colleges and universities now offer programs in mathematics education. Superintendents and school district personnel will come to me and my colleagues at other colleges and universities in Virginia requesting inservice training opportunities. It is becoming more and more difficult for us to provide them with the kinds of opportunities for inservice training that they need.

More attention needs to be directed to the potential of the summer institutes described in section 623. These institutes could be expanded to meet the needs of college and university faculty, not only in the schools of education but from departments of mathematics and science, as well as the needs of classroom teachers. Faculty teams could be brought together with teams of teachers to share faculty and staff development opportunities, to develop inservice programs for veteran schoolteachers, to design strategies for teachers and faculty to transport inservice back to schools and campuses, and to consider recruitment strategies that will encourage outstanding high school students to consider careers in teaching.

There are several important concepts inherent in this idea. First, teams of people should be encouraged to attend the institutes. One of the criticisms often heard of similar programs is that when only one individual attended from a school or district, it became very difficult for that individual to subsequently implement new programs or new ideas. Change is often slow. It is more easily effected by groups of people working together rather than by individuals working alone.

Second, the involvement of both school of education and arts and sciences faculty and administrators is essential. Teacher inservice should combine both subject matter and technique. To conduct institutes to sharpen only mathematics and science content has the danger of producing frustrated teachers who are highly skilled in content but cannot translate appropriately in a classroom setting. These people become prime candidates to leave the classroom for more lucrative positions in business and industry.

Clearly, we need to recruit the best and the brightest students into teaching. The concept of congressional scholarships is a good strategy, but it has several limitations.

First, since this legislation has a fiscal year 1983 implementation date, the first awards could not be made until the 1985–86 academic year. Consequently, it would be 1987 at the earliest, or possibly 1988, when these students would be entering the classrooms. If this strategy is designed to have an immediate effect on current shortages, I think it will fall short.

Second, awarding grants to students for their senior year of undergraduate school and/or for graduate work does not provide much of an incentive for young people to enter the profession. Further, this provision skews programs in favor of large colleges and universities offering either 5-year undergraduate teacher education programs or masters and doctoral programs. There is relatively little incentive for a student in a smaller liberal arts program institution to even consider applying for a scholarship if it is only applicable during the senior year.

Nor is the program an incentive for students from low-income families, many of whom are minorities. With the costs of a college education escalating, students cannot make a decision as sophomores to enter professional programs with the hope they will receive financial aid as seniors. I see this program, for all its good intentions, as a large Federal investment favoring without immediate impact and with the potential of favoring certain kinds of students attending certain kinds of institutions.

I believe there are some alternatives that could be incorporated into part B that would enhance cooperation between the elementary and secondary schools and the higher education community; develop and implement good recruitment strategies; and expand the impact of this legislation.

Part A provides relatively unfettered grants to school districts to purchase needed goods and services. I suggest a similar program for higher education so we can provide these goods and services.

Like the rest of our educational system, schools of education are facing difficult financial times. Although my own Governor, Mr. Robb, has a strong commitment to education, State aid is being cut. Unfortunately, new and innovative programs cannot be supported entirely by existing college or university funds. However, in many cases we do have the flexibility to commit some institutional resources to complement a Federal initiative.

Through a series of modest discretionary grants available to schools of education, we believe a stimulus could be provided for institutions of higher education to help initiate major reform at modest cost. The model I suggest is similar to the Deans Grant approach in part D of the Education of the Handicapped Act or the Bilingual Education Act, both highly successful programs administered for few Federal dollars.

I think we could accomplish a great deal with this strategy. We could bring together higher education faculty and school district faculty as well as representatives from business and industry to design and implement high quality instructional programs. Local level programs could mirror the kind of activity conducted at the summer science and math institutes as described in section 623.

We could work with our colleagues in departments of mathematics and science to establish computer camps for junior and senior high school students. With partial support through these discretionary grants, these camps would enhance students' skills and might serve as a recruitment vehicle for them into either careers in science or hopefully careers in science education.

We could hire teachers during the summer. This would strengthen the ties of practitioners to the higher education community. If we are willing to encourage businesses to hire teachers during the summer, why not provide some incentives for colleges and universities to do the same?

The attractiveness of this approach is that it can have substantial impact for a small Federal investment.

Mr. Chairman, on behalf of the schools, colleges, and departments of education located in institutions of higher education, we urge you to continue your commitment to our Nation's children, schools and teachers, and to enact legislation that will address the technological needs of our system.

Thank you, sir.

[Prepared statement of Charles Ruch follows:]

PREPARED STATEMENT OF DR. CHARLES RUCH, DEAN, SCHOOL OF EDUCATION, VIRGINIA COMMONWEALTH UNIVERSITY, RICHMOND, VA.

Good morning Mr. Chairman, members of the committee. I an grateful for the invitation to testify before you on H.R. 30, the Emergency Mathematics and Science Education Act. I am also delighted to learn that a fellow Virginian has been selected as a member of this committee. Representative Boucher, as you know, served with distinction for a number of years in the Virginia Senate where he was recognized as a good friend of education and a fine legislator.

I am here today representing the American Association of Colleges for Teacher Education. AACTE is a national professional organization of colleges and universities dedicated to teacher preparation and renewal; collectively our member institutions prepare over 80 percent of all new teachers each year.

The attention of the Congress is well directed to search for solutions to shortages of qualified mathematics and science teachers. The shortages are real and they are exacting a toll on our nation. I listened with interest to President Reagan's State of the Union Address the other evening and noted his concern about shortages of qualified scientists and engineers and the need to enact a program to fill these vacancies. As an educator I am glad that the President had identified mathematics and science education as a priority, yet I cannot agree with the focus of his statement. We haven't only a shortage of engineers or scientists, we are faced with the spectre of a technologically illiterate citizenry. To suggest only preparation of additional highly trained scientists and engineers as a solution is a simplistic and elitist approach.

A 1980 survey of high school seniors conducted by the National Center for Education Statistics revealed that only 34 percent had taken three or more years of math and only 20 percent had taken at least three years of science. Much publicity has been given to student declines on standardized mathematics and science tests. Yet, NCES reports that the "brighter", usually college bound high school students, are scoring better on these tests. What is disturbing about these data is that of the students taking more than three years of science, only 13 percent were general students and 9 percent were vocational students. The remaining 78 percent were all enrolled in academic programs. Our goal cannot be to develop a scientific and technological elite. We must carefully examine our school systems and enact the needed reforms to enhance critical thinking skills for elementary and secondary school children, and for students enrolled in all programs. These reforms must be integrated into every part of the school curriculum.

I would like to point out that shortages of qualified teachers are not limited to the scientific disciplines. There are shortages of qualified education personnel in many subjects in many geographic areas. A recently published summary of characteristics and attitudes of fall 1982 entering freshmen revealed that only 4.7 percent planned to become either elementary or secondary school teachers. If this is correct, shortages will multiply. We cannot seek resolution to these shortages and potential shortages without a significant federal, state, and local effort to recruit for classroom positions and to encourage them to remain in the profession.

Citizens, parents, teachers and children are waiting for a solution. The introduction of the Emergency Mathematics and Science Education Act is an important step. However, because the public's expectations are very high, and because economic realities dictate that the federal investiment must be modest, it is important that your deliberations result in legislation that school districts and institutions of higher education can use as a workable model to execute needed changes, and a model that can address current and future shortages in other areas.

I believe this legislation goes a long way toward the goal, but I am concerned that there are several strucural obstacles that might impede its successful implementation. Without altering the inherent principals undergirding the legislation, I believe some of these obstacles may be removed:

Parts A and B seem to exist in different worlds. No solution to this very complex problem can succeed unless all segments of the educational enterprise work in concert. for example, section 603 allocates funds to local school districts for a series of activities designed to upgrade the skills of teachers and administrative personnel as described in section 604. Use of community resources, including colleges and universities, is encouraged. But many colleges and universities are not prepared to deliver the kinds of inservice the school districts need, expect, and deserve. For example, in recent years the number of institutions of higher education offering mathematics and science training has declined. Only about 40 percent of all colleges and universities offer programs in mathematics education. Superintendents from school districts will come to me and my colleagues at other colleges and universities in Virginia and I don't know if we will be able to help them.

More attention needs to be directed to the potential of the summer institutes described in section 623. These institutes could be expanded to meet the needs of college and university faculty not only in the school of education but also in departments of mathematics as well as needs of classroom teachers. Faculty teams could be brought together with teams of teachers to share faculty and staff development opportunities, to develop inservice programs for veteran classroom teachers, to design strategies for teachers and faculty to transport this inservice back to schools and campuses, and to consider recruitment strategies that will encourage outstanding high school students to consider careers in teaching.

There are several important concepts inherent in this idea. First, teams of people should be encouraged to attend the institutes. One of the criticisms I have heard of similar programs is that when only one individual attended from a school or district it became very difficult for the individual to subsequently implement new programs or ideas. Change is often slow, and is more easily effected by groups of people than by individuals.

Second, the involvement of both school of education and arts and sciences faculty and administrators is essential. Teacher inservice should combine both subject matter and technique. To conduct institutes to sharpen only mathematics and science skills has the danger of producing frustrated teachers who are highly skilled in subject matter, but cannot translate it appropriately into a classroom setting. These people will then become prime candidates to leave the classroom for positions in business and industry.

Clearly, we need to recruit the best and the brightest students into teaching. The concept of "Congressional Scholarships" is a good strategy, but it carries several limitations.

First since this legislation has a fiscal year 1984 implementation date, the first awards could not be made until the 1985–1986 academic year. Consequently, it would be 1987 at the earliest and possibly 1988 when these students would be entering the classrooms. If this strategy is designed to have an immediate effect on current shortages, I think it may fail.

Second, awarding grants to students for their senior year of undergraduate school and/or for graduate work doesn't provide much of an incentive for young people to enter the profession. Most students must make their decision to enter a teacher preparation program before their junior year and enter the classroom upon receipt of an undergraduate degree. To wait until they are seniors, only extends the amount of time they must spend as an undergraduate. In addition, this provision skews the program in favor of large colleges and universities offering either five year undergraduate teacher education programs or masters and doctoral programs. There is relatively little incentive for a student in small four year institutions to even consider applying for such a scholarship if it only is applicable to the senior year. Nor is the program an incentive for students from low income families, many of whom are minorities. With the costs of a college education escalating, students cannot make a decision as sophmores to enter professional programs with the hope they will receive financial aid as seniors. I see this program, for all of its good intentions, as a large federal investment favoring certain kinds of students attending certain kinds of institutions.

I believe there are some alternatives that could be incorporated into part B that would: (1) Enhance cooperation between the elementary and secondary schools and the higher education community; (2) Develop and implement good recruitment strategies; and, (3) Expand the impact of this legislation.

Part A of this legislation provides relatively unfettered grants to school districts to purchase needed goods and services. What I am suggesting is a similar program for higher education so we can provide these goods and services.

Like the rest of our education system, schools of education are facing difficult financial times. Although my own Governor, Mr. Robb, has a strong commitment to education, state aid is being cut. Unfortunately, new, innovative programs cannot be supported entirely by existing college or university funds. However, in many cases we do have the flexibility to commit some institutional resources to complement a federal initiative.

Through a series of modest discretionary grants available to schools of education we believe a stimulus could be provided for institutions of higher education to help initiate major reform at modest cost.

The model I suggest is similar to the "Deans Grant" approach in the Part D of the Education of the Handicapped Act and the Bilingual Education Act, both highly successful programs administered for few federal dollars.

We think we could accomplish a great deal:

We could bring together higher education faculty and school district personnel as well as representatives from business and industry to design and implement high quality instructional programs. Local level programs could mirror the kind of activity conducted at the summer science and mathematics institutes described in section 623.

We could work with departments of mathematics and science to establish computer camps for junior high and senior high school students. With partial support through these discretionary grants, the camps would enhance student's skills and could serve to recruit them into teaching careers.

We could provide some faculty release time to allow us to transport inservice programs and equipment to remote areas.

We could hire teachers during the summer. This would strengthen the ties of practitioners to the higher education community. If we are willing to encourage business to hire teachers during the summer, why not provide incentives for colleges and universities to do the same thing?

The attractiveness of this approach is that it can have substantial impact for a small investment.

Let me describe for you the way this kind of a program operates in Virginia. Spured by concerns that students graduating from our high schools did not have adequate writing skills, the state of Virginia awarded small grants to six institutions of higher education across the state. With VCU's grant the university was able to bring a team of English teachers, English faculty, and school district personnel to our campus during the summer for intensive work on writing skills and how to teach writing at the junior high and high school levels. Higher education faculty members became more sensitive to the needs of the junior and senior high schools. The twenty-five teachers who were part of our program returned to their schools in the fall and conducted inservice programs for their colleagues. Assistance was provided to the classroom teachers by faculty members who had been part of the summer program. The ultimate beneficiaries, of course were the students in Virginia's secondary schools.

Mr. Chairman, distinguished members of the committee, on behalf of the schools, colleges, and departments of education located in institutions of higher education we urge you to continue your commitment to our nation's children, schools, and teachers and to enact legislation that will address the technological needs of our entire education systems.

Mr. SIMON. Our next witness is Robert B. Gaither, chairman of the Department of Mechanical Engineering, at the University of Florida.

STATEMENT OF ROBERT B. GAITHER, CHAIRMAN, DEPARTMENT OF MECHANICAL ENGINEERING, UNIVERSITY OF FLORIDA

Mr. GAITHER. Thank you, Mr. Chairman.

The organizations that I represent are in the written record, so I will not further introduce myself other than to note that one suggests that I am going to speak on behalf of the teachers. I plan to do so.

It is apparent to me, in listening to the previous testimony, that this group of Congressmen certainly are aware of the seriousness of this particular problem. They have been given some input, and I would like to certainly congratulate all of the previous people for the information that they have conveyed to you. I agree with a great deal of it. There are some places, of course, where I would tend to disagree, but I believe the problem is recognized and I would hope that you got pretty quickly—and I guess that's your objective—down to the solution part of it.

I am going to offer you five points here which I believe honestly and sincerely will strengthen your bill. I think it is a good bill.

First, in section 604, or part A, I feel that putting more money into certification and recertification is a negative approach. First of all, it is a problem that the States must address themselves; they must pay for it. I don't think that is a cost-effective way for you to use your funds. I would rather see your allowing the development of specific strategies, develop a reward system, for the mathematics and science teachers.

I am possibly not the oldest person in this room, but I have had a few years of experience and I can remember when I was back in high school—and I would challenge the others here to do so as well. If you want to improve the situation in the mathematics and science classrooms, improve the status of that teacher. I'm not being facetious about this whatsoever.

Top on their list, by the way, is to put a telephone on their desk like the football coach has. Give them a student assistant. Fix up their laboratories to the point where they have at least something other than a shambles. There are students today who don't take the science courses because they don't like that room.

I have presented for the written record some other suggestions along these lines and I won't belabor the point because I see the hour.

Second, it is a known fact that primary and secondary schoolteachers—and I will not belabor the point—receive less attractive financial awards than their fellow citizens in other areas of employment. What is not well known is the fact that some of them, and especially those who are the most dedicated and the most successful and the most effective, supplement the meager budgets they have to operate their laboratories with their own funds.

I would suggest that you try and find a way to allow such teachers to get tax credits for doing so. You're not going to make much money on it because—there is not that much money involved in it—because they are not making much money to begin with. But I think it would be a step in the right direction and I believe that some of these science teachers in high school and the primary schools would regard it as "somebody up there in Washington is concerned about me."

Item 3, the Nation's technical societies, of which ASME, one of the organizations that I represent, the American Society of Mechanical Engineers, is but one, constitute an enormous reservoir of scientific talent in this country. I'm talking on the order in excess of 2 million people. I would strongly recommend that you challenge them in your bill to help.

Now, I have been told when I came in here to be careful when I said that, because you might ask me, as I leave here, to come up with some plan. Let me say right now, I am prepared to do so. I can certainly call upon my society, and I have friends in the other societies, which will come up with such ideas as strategies to assist mathematics and science teachers, provide personnel to lecture on specific subject matters, help out some of those science teachers in the classrooms, develop public awareness programs, develop, supervise and monitor special education and training programs. I could go on.

Item 4. People have been talking so far about $300 million is not enough money. That's an incredible amount of money in my book, and it is very close to April 15. It frightens me. And, yet, I know that a lot of funding is needed. As was pointed out earlier, we're getting down to a few hundred dollars per high school, which isn't very much. I do know of a high school where the entire biology department budget for microscopes, slides and equipment was $25 in 1980. We helped out. We increased it immediately by 100 percent. We sent her a $25 check.

You need to include the National Science Foundation and several other Government agencies, including those in the Defense Department who need to have adequately trained scientific and mathematically trained personnel to operate the sophisticated hardware that they have. But, certainly, the National Science Foundation, which has an excellent track record should be included. It would appear to me that binding them into your bill and providing for them a deeper involvement, would further strengthen the objectives that you have in your bill.

My friends in sociology and psychology tell me that involvement is good because of the first law of psychology. That is, people will support and back and work for that which they have helped to create.

Finally, item 5, on congressional scholarships, I might add that 300 or even 600 scholarships for tuition and fees is not very much of an incentive. We are talking about State universities, where this is on the order of a $1,000 in some cases less. That kind of scholarship exists and is available in the private community. Although if you said "Congressional scholarships," that puts some more meat into it if it showed you meant business and you wanted to get into those high schools and help out those people. I honestly believe, however, that those funds might be better spent on workshops, the summer institutes, and student assistance, and paid student assistance for those science and mathematics high school teachers, who are teaching on the order of 6 to 8 classes of 40 students per day.

In closing, I would offer my compliments to the authors of H.R. 30. I believe it is a positive response to a critical need. I trust my emphasis on this particular area will not be misunderstood. I believe it is a good bill. I think it could be strengthened. I think it's an enormous opportunity for Congress to display some true leadership.

For your benefit, Mr. Chairman, I might add a little homily. In fact, it turns out that I had actually put it into the record myself. I happen to be a person who has command of another language besides English. Unfortunately, I am a bad example because I did not learn it in school. I learned it on my own. I am convinced myself, and I share with you this conviction, that the best single predictive indicator of whether a student will ever be successful in engineering is his or her grades in high school English.

Thank you very much.

[Prepared statement of Robert Gaither follows:]

PREPARED STATEMENT OF ROBERT B. GAITHER, CHAIRMAN, DEPARTMENT OF MECHANICAL ENGINEERING, UNIVERSITY OF FLORIDA

My name is Robert B. Gaither. I would like to add my compliments and support to the fine presentations that have already been made before this Committee, and thank you for this opportunity to testify on the current crisis in mathematics and science education.

I will base my remarks on my experience in three separate, but complementary roles. The first is, I am an educator in the field of mechanical engineering. In this field the problems you are addressing with H.R. 30 come home to roost in an especially critical way. Mechanical engineering is not a specialty. It is a basic discipline, including such specialties as: Robotics, Bio-engineering, and manufacturing. As a matter-of-fact, mechanical engineering is recognized as the broadest of the engineering disciplines. William Everett (an eminent scholar and former Dean of Engineering at the University of Illinois) perhaps described it best when he said, "if it moves, a mechanical engineer designed it." I have been a mechanical engineer for more than 30 years, 18 of which have been as a Professor and Head of the Department of Mechanical Engineering at the University of Florida.

My second role is, the Immediate Past-President of The American Society of Mechanical Engineers (ASME), a large volunteer technical society. I am also a Past Vice President, Education, for ASME. My successor in that post, Dr. Leroy S. Fletcher, Associate Dean of the College of Engineering at Texas A&M University, was also invited to testify before this Committee but asked my to express his regrets for not being able to attend.

ASME was formed 102 years ago and has a current membership of some 110,000. It is a volunteer society with an enormous array of resources including thirty-two separate technical divisions, two major magazines, a newspaper, 14 journals, the ASME Codes and Standards and a host of other technical papers. It is recognized as one of the 10 largest publishing houses in the world and is comprised of a literal army of dedicated and technically expert men and women. We are all personally and professionally aware of the need for action to improve the mathematics, science, and engineering education in this county.

My third role is, Chairman of the Board of Directors of the Florida Foundation for Future Scientists; a non-profit, volunteer organization dedicated to encouraging Florida's youth to seek and secure rewarding careers in mathematics, science and engineering. Evidence of what I believe is an impressive record of achievements are that: (1) Florida high school students won more awards at the 1982 International Science and Engineering Fair in Houston, Texas than any other state or nation; (2) the same students won second place in the Westinghouse Science Talent Search Awards.

With this as a background, I have the following specific suggestions to make on H.R. 30:

(1) Part A; Section 604 ("Use of Funds by Local Educational Agencies"): I feel that putting more money into the certification and recertification of teachers is not the best use of funds. The states clearly have some work to do in this area but, for the purposes of this bill, support of such actions should have low priority. A better use of federal funds would be to develop strategies to demonstrate the importance of the science and mathematics teacher. This would encourage qualified people to compete

for the available positions. While there are numerous ways this can be accomplished, I suggest three that I an convinced would offer immediate results:

(A) Provide the mathematics and science teachers with student assistants. This is a double barreled thrust. Not only will this provide the teacher with status and much needed assistance but it has the potential for starting a "Little League" of future mathematics and science teachers.

(B) Provide incentives to industry to equip the basic science and mathematics laboratories so they become the hallmark of the schools.

(C) Provide mathematics and science teachers with the highest priority in gaining access to the use of such community facilities as museums, public laboratories, zoos and similar educational resources.

I could to on, but I know that the basic thrust of this suggestion is to make every effort to get money and assistance directly into the classroom where it can have a meaningful and immediate effect.

(2) It is a known fact that all primary and secondary teachers receive less attractive financial rewards than their fellow citizens in other areas of employment. What is not as well known is the fact that some of them—especially the most dedicated and effective—supplement their meager equipment, supply and maintenance budgets with their own funds. Is it possible that H.R. 30 can provide a means by which these teachers and others are provided with tax credits for such out-of-pocket expenses? As awkward as this suggestion may appear to some, I must admit, I don't know of a more efficient use of tax dollars than direct expenditures by the persons most knowledgeable of the need.

(3) The nation's technical societies, of which ASME is but one, constitute an enormous reservior of scientific talent. Indeed, the two million plus volunteer members of these societies comprise the largest reservior of scientific talent in the free world. How can they help? Challenge them to carry out actions including, but not limited to, the following:

(A) Plan and organize strategies to assist mathematics and science teachers.

(B) Provide personnel to lecture on specific subject matter, act as judges in contests, and work on the development of novel schemes of instruction.

(C) Develop public awareness programs.

(D) Develp, supervise and monitor special education and training programs for science and mathematics teachers.

Clearly there are many other things that these societies can do. Challenge them!

(4) The National Science Foundation is specifically chartered to provide assistance to mathematics and science education. It is a federal government agency that is highly respected by mathematics and science teachers and it has conducted a significant number of successful programs in the past. It would appear that H.R. 30 could be strengthened considerably if a deeper involvement by the National Science Foundation is to be accomplished.

(5) Part B; Section 621 ("Congressional Scholarships"): The expenditure of significant amounts of money to provide congressional scholarships to 300 people in the first fiscal year and 600 in the second does not appear to be very cost effective. Putting these funds into workshops, student assistant programs and matching grants for equipment and maintenance would be. I stress the maintenance because I have seen too often situations where expensive equipment is not used because of the lack of funds available for maintenance.

In closing, I offer my compliments to the authors of H.R. 30. It is a positive response to a critical need. I trust my suggestions and emphasis on assisting mathematics and science teachers will not be misunderstood. I believe all primary and secondary school teachers are in need of assistance. Indeed, I am personally convinced the best predictive indicator of whether a student will be successful in engineering, is his or her record of grades in high school English.

Thank you. I will be pleased to answer any questions.

This statement was prepared by Dr. Robert B. Gaither. It represents the considered judgment of this individual, an expert in this field, rather than an official position of The American Society of Engineers.

Mr. SIMON. I thank you very much for your excellent and very concrete suggestions.

Incidentally, one of the suggestions which you make, unfortunately we can't include in the bill because we get into a turf problem. Universities are not the only places that have those problems. It is a suggestion that I had not heard before but I think makes a great deal of sense. That is a tax credit to teachers who do contribute, because I know myself there are teachers who have bought the basics that they felt were absolutely essential and have no assistance for that at all at this point. This is under the jurisdiction of the Ways and Means Committee rather than our committee. But maybe we ought to be introducing a separate bill to do that. In terms of Federal dollars, it would be almost inconsequential, and yet it would be at least saying "thank you" to those teachers.

Our final witness is Stephen Willoughby, the president of the National Council of Teachers of Math.

STATEMENT OF STEPHEN WILLOUGHBY, PRESIDENT, NATIONAL COUNCIL OF TEACHERS OF MATH

Mr. WILLOUGHBY. Thank you.

One of the disadvantages of going last is that everybody has already said what you have to say, and one of the advantages is that will shorten what I have to say, since I have already been quoted several times and referred to on quite a few occasions, both by the first panel and this panel.

The demands of an increasingly technological society for a quantitatively literate population are great and growing. The main roadblock to providing mathematically competent future citizens is an insufficient number and decreasing supply of qualified teachers of mathematics. H.R. 30 is a small step in the right direction. What we need is a giant leap.

The shortage of people who are capable of thinking intelligently at all levels about space and numbers is great and it is increasing. The shortage exists at the levels of laborers, supervisors, secretaries. It exists at the level of people who testify before congressional committees and can't keep their testimony to less than 10 minutes. I will try.

Statistics showing the decreasing number of State certified mathematics teachers abound and are frightening. I have quoted some in my written report and will not requote all of those now. To me, a more serious but hidden problem is perhaps the decreasing quality of the people who are certified to teach. Because of the shortage of mathematics teachers, States are, in fact, lowering their standards to be certified. Sometimes they do this through actually changing the written documents; more often, they do it through the administrative procedures, by simply waiving at something that would not have been counted as a mathematics course 5 years ago and now it will be counted because we need that body in the classroom.

I take one simple example, of a young man who I know, who was certified to teach mathematics in New York State. He had failed the regent's exams in 10th grade geometry on five separate occasions. He never passed the regent's exams in 10th grade geometry. He never passed a course in 10th grade geometry or any course in mathematics more advanced than 10th grade geometry. And yet he was certified to teach not only 10th grade geometry but 11th grade algebra, 12th grade algebra, trigonometry, and, in fact, calculus and a second year of calculus if it happened to have been taught in a school where he was teaching.

There are still many highly competent and dedicated mathematics teachers. In fact, the thing that is amazing to me is that there are so many competent and dedicated mathematics teachers still today. But the probability that a given student will benefit from an excellent mathematics teacher is decreasing rapidly.

Local communities are unlikely to deal with the problem effectively because of a combination of other serious local issues, and because of the extreme mobility of the modern American family. According to the latest census, more than 40 million Americans move each year. Now, if that is the case, it is hard to get the local community to put large investments into a child who will grow up and work and be a citizen in quite a different community.

Increasingly, in a technological society, the Federal Government has a vested interest in the education of future citizens. Because of the duties of citizenship, because of the needs of the economy, and because of the national defense, at this time in history education is of more importance to the long-range common defense and general welfare than is any other single factor. H.R. 30 is a step in the right direction. Unfortunately, at a time when we need a giant step, it is a baby step.

To provide tuition scholarships for 300 students to become teachers each year is surely the proverbial "drop in the bucket". There are 160,000 secondary school mathematics teachers in this country, and according to a 1981 National Science Foundation survey, 25 percent of them expect to leave the classroom for other jobs. Los Angeles city, by itself, required 400 new mathematics teachers last year. You are proposing to create 300. Los Angeles could do away with all of them and still have a shortage of 100 teachers.

If the numbers were great enough to make any difference, I would suggest that there be some substantial changes in the scholarships. I would suggest they start at the freshman year, as was suggested earlier, so that we can attract people right away into the operation and let them last for up to 5 years. I would suggest that we forgive 1 year of the scholarship or loan for every 2 years of teaching, so you don't have to go through the full 5 years to get that reward of having taught for a while.

I would suggest that the grades that these are based on be math and science grades rather than just general grades, and that perhaps if we include freshmen that they include SAT scores or other entry scores.

The proposed money for support of research is certainly welcome, but unfortunately producers and buyers of textbooks, classroom teachers, and the other people who actually determine what happens in the classroom, seem blissfully unaware of the research that is already available. Perhaps more money is needed to disseminate the research findings and encourage people to act upon them.

The suggestion that research should be supported "particularly at the secondary level" is most inappropriate for mathematics. Children learn a great deal of mathematics in the elementary school and that learning is the foundation for both secondary school mathematics and secondary school science. Because mathematics is a sequential subject, and because it is essential to the study of most science, ignoring elementary school mathematics in research projects or any other form of support would be very shortsighted.

Mr. SIMON. If I may interrupt you right there, are you suggesting that, in fact, it ought to be elementary rather than secondary? Or that we simply drop——

Mr. WILLOUGHBY. If I had a choice, I would prefer elementary rather than secondary, but I would really prefer that it be both. My preference would be both. But if I had to take the choice, what happens in the elementary school, in the long run, is going to be more important to the future mathematics and science background of people in this country than what happens at the secondary level.

Does that answer your question?

Mr. SIMON. Yes, thank you. I'm sorry to have interrupted.

Mr. WILLOUGHBY. That's quite all right.

The $250 million to be authorized for inservice teacher training, evaluation, and use of local resources and modernizing programs and equipment comes to less than $5 per pupil after the state agency set asides. Hardly enough to make a dramatic difference.

Even if we were able to dramatically improve the qualifications of some math and science teachers with this very small amount of money, and the even smaller amounts in the higher education section, we could expect many of those whose skills had been improved to leave to go into higher paying jobs in industry and government as soon as they finish the courses.

Helping teachers of other subjects get recertified to teach mathematics tends to lower the standards. Teachers whose livelihood depends upon their changing subjects usually meet the absolute minimum State requirement for certification, are often not interested in the subject to which they were forced to switch, and may be expected to simply abide their time until they have enough seniority to go back to teaching the subject that was their first love.

There are other possible short-term or regional plans that may or may not be effective in dealing with the crisis, but I believe that the common defense and general welfare of the Nation—I'm quoting from the Constitution, as I am sure you're aware—are more dependent on education than on the development or deployment of any particular technological innovation. What we need is a major reassessment of our national priorities, so that rather than asking how will we pay for education, we should start with education at the top of our list and then we should ask how will we pay for the many other things that are desirable, that are less necessary for the long-range defense and welfare of the Nation.

If a true commitment were to be made to improving the education of our youth, I would propose the following four steps. I propose them in this order because this is perhaps the most important order.

First, to improve the conditions within classrooms of this country so that a teacher can teach, rather than spending all of his or her time on discipline, so that there is substantial professional support to join professional organizations, to continue improving your work. I don't think adding a telephone on the desk would have any major effect, but I would be delighted if you could tear out every loudspeaker in the system so that some idiot principal couldn't get on it in the middle of my class and interrupt it with some statement about what is going on in the parking lot.

Two, to increase the school year to at least 220 days. I feel that we lose a tremendous amount in our educational system by the long hiatus that occurs every summer. I know that two of the most attractive things about teaching are July and August, but I think we have still got to change this situation and take education more seriously the year round.

Three, to improve the standards for becoming and for remaining a teacher. My organization and many other organizations have set down standards which are generally ignored by State certification rules and others.

Four, double the salary of every teacher in the country with a major share of the increase coming from the Federal Government. There is a crisis in education today that will profoundly affect the future of the Nation. If we act by doing just a little, we may fool ourselves into believing that we have solved the problem, when we have, in fact, only succeeded in putting it out of our minds. Too little action may be worse than no action at all.

Thank you.

[Prepared statement of Stephen Willoughby follows:]

PREPARED STATEMENT OF STEPHEN S. WILLOUGHBY, PRESIDENT, NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

Demands of an increasingly technological society for a quantitatively literate population are great and growing. The main roadblock to providing mathematically competent future citizens is an insufficient number and decreasing supply of qualified teachers of mathematics. "The common defense and general welfare of the United States" require a significant national commitment to education. H.R. 30 is one small step in the right direction. What we need is a giant leap.

According to one survey at the University of California, 92 percent of the women and 43 percent of the men in the freshman class had already disqualified themselves from three-quarters of the possible majors for lack of sufficient mathematics. A 1982 survey by the Center for Public Resources found that according to business representatives mathematics and science skills are below what are needed even in the less advanced jobs and in secretarial and supervisory positions.

Facts of this sort have already influenced state and local education authorities to increase the requirements in mathematics, science, and computer science. Colleges and universities are raising their standards in mathematics and science for entry. But even without such requirements, high school students have begun to take more mathematics, science, and computer science because they correctly perceive these as the skills that will be needed in the world of the future. For the foreseeable future there will be a greater demand for, than supply of, people who can and will think quantitatively and make intelligent decisions regarding real-world situations involving number and space. The problem is serious, but the young people of the nation, with and without guidance from their elders, are beginning to rise to the challenge.

Another problem that has been critical is rapidly becoming more critical as school students take more mathematics and computer science. With the exception of one or two years (1969–1970) there has been a documented shortage of mathematics teachers for the past 40 years in this country. The shortage is rapidly getting worse. Some of the reasons include: .

(1) There has been a 77 percent decline in the number of secondary-level mathematics teachers prepared in the past ten years, and only about 55 percent of those prepared to teach mathematics actually enter the teaching profession. In Missouri, for example, the number of college graduates who could have been certified to teach mathematics from the class of 1973 was 443. In 1981 the figure was 95. In 1982 it was 57.

(2) Almost five times more mathematics and science teachers left the profession for nonteaching jobs than left for retirement in 1980, and the demands of industry and government for more mathematically trained individuals are increasing.

(3) The demands for computer courses in school are being met primarily through the efforts of mathematics teachers who are then available to teach fewer mathematics courses.

Perhaps the most surprising fact about the situation is that there are so many dedicated, well-qualified teachers still teaching in this country. Teaching is certainly the most important and difficult profession known to the humam race. Our destiny is dependent upon the minds of our future citizens. The human mind is the most complex and remarkable thing on the face of the earth—by comparison the most advanced computers look like oversized Tinkertoys. Yet, we have entrusted those minds to the members of one of our most underpaid, overworked, and undervalued professions. It is amazing that anybody who is competent to do the job is willing to do it. Somebody once remarked, correctly, that any competent teacher who continues to teach is truly committed—or truly ought to be.

In spite of the fact that there are many dedicated, competent teachers in the schools of the nation, there are not nearly enough—especially in the areas of mathematics and the physical sciences (physics and chemistry). Although there appear to be live bodies in front of most mathematics classrooms in the country, those who are teaching are often grossly underprepared. Last year 50.2 percent of the newly hired science and mathematics teachers were judged unqualified by the principals who hired them. And, a principal ordinarily considers a teacher qualified if the teacher meets state certification requirements. In many states, a reasonably imaginative prospective teacher can be certified to teach mathematics with far less than adequate preparation. For example, I know one young man who received certification to teach mathematics in New York even though he had failed the Regents' Examination in tenth-grade geometry on five separate occasions and had never passed either geometry or any more advanced mathematics course.

The lack of enough qualified mathematics teachers is unfortunate for the many students who will have to learn mathematics without adequate instruction. If they fail to learn, understand, and appreciate mathematics, it will forever prevent them from understanding and dealing with the world as well as they might have. Beyond that, their options for pursuing future education and for fulfilling their occupational goals will be severely limited. Because of the needs of individuals, local and state school authorities have an obligation to do everything in their power to provide adequate teachers and an adequate education for all children in every school in their jurisidictions. Unfortunately, local voters are aware of the great mobility of the modern American family (40 million Americans—almost one-fifth of the population—move every year), so they are often unwilling to provide the tax revenues with which to give a quality education to a child who will probably become a citizen of, and be employed in, another community. Thus, what was once a local responsibility for education ought now to be shared by the federal government.

Beyond the natural interest of each individual in acquiring an adequate education the nation has a vested interest in the education of every citizen.

The rights and duties of citizenship require an education citizenry, and in an increasingly technological society, that education must include mathematical and scientific reasoning.

The economic future of each nation is becoming more dependent upon the mathematical and scientific education of its citizens—a fact that has been recognized and acted upon by our major economic competitors.

Finally, the very defense of the nation is now dependent upon the education of our citizens. Two hundred years ago the nation was defended with musket and cannon, and armies traveled on foot or horseback a higher education was of little need to the defenders of our country. Today we find that army recruits do not know enough mathematics to understand the manuals written to help them run the sophisticated military equipment on which the nation is investing so much.

Congress has the power and obligation to "provide for the common defense and general welfare of the United States." Today, that power and that obligation require Congress to act to assure the adequate education of the children of the United States.

H.R. 30 is a step in the right direction. Unfortunately, it is a baby step at a time when we are in need of a giant step.

To provide tuition scholarships to 300 students each year to help them become teachers is surely the proverbial drop in the bucket. There are 160,000 secondary school mathematics teachers in the country, and according to a 1981 National Science Foundation survey, 25 percent of those expect to leave the classroom.

The funds for improving college programs and faculty, especially in technological areas, may be expected to have a reasonably positive effect on some colleges but are not likely to trickle down to the elementary and secondary school level in any significant quantity.

The proposed money for support of research is certainly welcome, but, unfortunately, producers and buyers of textbooks, classroom teachers, and others who actually determine what happens in the classroom seem blissfully unaware of the research that is already available. Perhaps more money is needed to disseminate research findings and encourage people to act upon them.

The suggestion that research should be supported "particularly at the secondary level" may be appropriate in science education where relatively little is taught at the elementary school level, but it would be most inappropriate in mathematics. Children learn a great deal of mathematics in the elementary school, and that learning is the foundation for both secondary school mathematics and secondary school science. Because mathematics is a sequential subject and because it is essential to the study of most science, ignoring elementary school mathematics in research projects would be a very shortsighted move indeed.

The $250,000,000 to be authorized for in-service teacher training, evaluation and use of local resources, and moderning programs and equipment comes to less than $5 per pupil after state agency "set asides." Hardly enoung to make a dramatic difference.

Even if we were able to dramatically improve the qualifications of some teachers of mathematics, computer science, and the physical sciences with this small amount of money (and the even smaller amounts in the higher education section), we could expect many of those whose skills had been improved to promptly leave teaching to go into higher paying jobs in industry and government.

Insofar as the in-service education helped teachers of other subjects to be recertified in mathematics or science, the action would tend to lead to a lowering of qualifications. Teachers whose livelihood depends upon their changing subjects usually meet the absolute minimum state requirements for certification, are often not interested in the subject to which they were forced to switch, and may be expected to simply bide their time until they have enough senority to go back to teaching the subject that was their first love.

Many short-term solutions to the crisis in mathematics and science education have been proposed, and some are being tried by state and local education officials. These include salary supplements based on shortage, loans for prospective teachers in shortage areas with foregiveness of parts of the loans for each year of teaching, improved conditions (increased planning time, reduced nonprofessional work such as supervising study halls and lunch rooms, more support for attendance at professional meetings and for graduate work, etc.), and encouraging industries to hire mathematics and science teachers during the summer to enhance their incomes and their knowledge of how their subjects are used in industry. If sufficient resources were poured into solutions of this sort, there would certainly be an effect. Insofar as salary supplements are offered by one state or locality, those supplements are likely to produce a reallocation of mathematics and science teachers but will probably not substantially increase the number of such teachers in the nation as a whole unless the supplements are of the order of magnitude of $10,000 per year or more, since that is what would be required to compete with salaries offered to the same people in industry. The problem with such additional support for teachers of shortage subjects is the pernicious notion that might be fostered that those teachers are somehow better or more important than the teachers of other subjects—the only justification for such supplements would, of course, be the law of supply and demand.

If we are the solve the long-term crisis facing the nation in education, the Congess and the President must take seriously the charge to "provide for the common defense and general welfare of the United States." And, they must realize that the long-range defense and general welfare of the nation are more dependent on the education of our youth than on development or deployment of particular technological innovations. With a federal budget in excess of 700 billion dollars, there has to be room for a few billion dollars to improve the education of our children and thus insure the future defense and economic welfare of the nation.

If a true national commitment were to be made to education, I would propose that the following four steps be taken:

(1) Improve conditions within the schools. Make clear to our educators what they are supposed to be achieving and what they are not responsible for doing. Provide strong support for maintaining discipline within the classrooms so education can proceed. Provide better educational materials and better opportunities and support for teachers to evaluate those materials and use them effectively. Provide better equipment and other facilities. Provide more opportunity and incentive for teachers to continue their professional development through participation in activities of pro-

fessional societies and through further formal education. Beyond this, students, parents, and other citizens should openly show excellent teachers the respect to which they are entitled for doing a difficult job well—and many of our present teachers ARE doing the job magnificently.

(2) Increase the school year to at least 220 days. The education lost during the summer is far greater than the simple lack of having learned for 40 or so additional days. Any teacher can tell you that students forget a great deal over the summer, and much of the first month back is spent relearning that which has been forgotten.

(3) Improve standards for becoming and remaining a teacher. Professional organizations such as the National Council of Teachers of Mathematics have published standards for becoming teachers. These standards, by any reasonable criteria, are minimal given the job the teacher is expected to accomplish. However, state certification requirements are invariably lower than the standards advocated by the profession, and many states have tended to lower those standards still further in light of shortages. But, beyond the need for higher entry standards, we must realize that the world is changing and teachers must change with it or be unable to provide students with an up-to-date, appropriate education. A teacher who is certified today at the age of 22 could still be teaching in the year 2031. Although the world will certainly have changed by then, most states do not require the teacher to have learned anything new in that time.

(4) Double the salary of every teacher in the country. Double the salaries of those in shortage areas and in nonshortage areas, of those who are good and those who are not so good. Does this mean that some incompetent teachers will be overpaid? Of course. But any teacher who is incompetent is already overpaid. Changes proposed here would greatly improve the quantity and quality of people trying to become teachers and would improve the procedures used to select and educate those people, as well as making it possible for the many fine teachers who are already teaching to concentrate more effort on improving their teaching still further. Without such dramatic action, this nation can expect to gradually lose its predominent place in the intellectual, technological, economic, and creative activities of the world. Because the general welfare of the nation is at satke, the Congress has both the power and the obligation to act. The financial support for this improvement should probably come largely from the federal government, so that when federal funds are matched by local and state governments, the federal government would be paying about one-third of the cost of faculty salaries in schools.

There is a crisis in education today that will profoundly affect the future of the nation. If we act by doing just a little, we may fool ourselves into believing that we have solved the problem when we have in fact only put it out of our minds. Too little action may be worse than no action at all.

Mr. SIMON. I thank you for an excellent statement.

If I can just make a couple of comments—and your statement really ties in with Dean Ruch's testimony here earlier, we have to face up to the problem and what you're talking about goes really far beyond math and science.

Mr. WILLOUGHBY. Yes, sir.

Mr. SIMON. And that is, where we are going as a nation, what our priorities ought to be. My subcommittee held hearings last year, the last 2 years, on the problem of the quality of teachers. First of all, to my knowledge, it was the first time in the history of the Nation that such hearings have been held. There was resistance even to the idea of holding hearings on the question. And then, frankly, it was unclear what we ought to be doing. We introduced a resolution to simply call on the States to set up commissions to look at the whole question of where we're going and what the quality ought to be. We introduced it under a procedure we call a suspension, which requires a two-thirds vote, and we did not get—we got a majority but we did not get a two-thirds vote even for that modest proposal because there were many who felt the Federal Government shouldn't be paying any attention to this problem of quality in teachers, that that's not the business of the Federal Government.

It really gets down to where we ought to be going and what we ought to be doing. I share your concern. I would love to see much of what you suggest enacted tomorrow. We are not going in that direction right now.

You mentioned, Dean Ruch, the 4.7 percent. It is down to 4.7 percent of those who are going into teaching. My concern is not simply the 4.7 percent but who the 4.7 percent are. If we believe that we determine the future of this Nation through education, and I believe we do, then we had better take a look at the most important ingredient, and that is the teacher. That gets back to Dean LeFevre's one word that we have paid much too little attention to, and that is quality. We simply have to do something.

Then we can look at something like 220 days. It's interesting, that Japan has 250 days a year. They are our competitors and we hope they will stay our friendly competitors. The Soviet Union student goes to school 6 days a week, not 5 days a week. So that I don't get in trouble in southern Illinois, I am not here advocating either one of those things. [Laughter.]

But I think we had better recognize the world in which we live, and we had better determine what our priorities are, and how you really secure the kind of national security that we are talking about. You have all been excellent witnesses and I appreciate it.

I apologize again. We ended up with far too many witnesses today, and you ended up here being on the program much too late. My apologies and my thanks. I think you have contributed a great deal, and while we are not going to be able to incorporate all of your suggestions, I think the final bill will show evidence of your testimony, and I hope, more important than that, where we go in the future will show evidence of your testimony. We thank you again very much. I would like to include for the record at this point, suggestions from Dean John E. Sandberg from Western Michigan University.

The subcommittee stands adjourned.

[Whereupon, at 2:45 p.m., the subcommittee was adjourned.]

A Plan To Improve Math Education at the Elementary and Middle School Level

ELEMENTS OF THIS PROSPECTUS

(1) To forge partnership between business and public school systems to provide math teachers.

(2) The first five-years of employment with business and industry will be spent teaching in a public school system.

(3) Low interest loans will be forgiven at the rate of 20 percent for a year of teaching.

(4) Business and industry have been provided incentives by the government for participation in this program.

The need to strengthen math instruction in the Nation's schools is generally recognized. The pool of Americans with math skills continues to dwindle. As we move to an ever more technical society, personnel with math skills must be available.

It is in the interest of American business and industry that elementary and secondary math instruction be strengthened. In recognition of this fact, it is proposed that they join with school systems in a joint program. With support from the Federal Government, a continuing solution can be forged.

The salary structure for teachers makes it difficult for schools to compete against business and industry for top flight personnel with math skills. Not only are beginning salaries low, but teaching salaries tend to top out at a time that other professional salaries start to move up sharply. Paying beginning bonuses or salary differentials will only provide temporary relief, and, in doing so take strong objection from teacher unions and other organizations.

It is proposed that a network of American business and industry be formed and that these businesses and industries make a commitment to strengthen math instruction in American schools. The business and industry community will hire university graduates, mathematic equipped teachers. These individuals will be placed in math teaching roles for their first three to five years of their employment with their company. They will provide summer employment and/or support for further education.

The Federal Government will provide incentives for business and industry that participate in this program. These incentives could be in the form of a favored status as a supplier or a contractor. Tax relief could be provided. For example, proof of hiring a teacher with five years of experience would credit them with some form of incentives.

The Federal Government will provide students who pursue a math teaching curriculum with low or no interest loans. These loans will be forgiven at the rate of 20 percent a year of successful teaching experience.

School systems will pledge to do two year salary averaging for math teachers for as long as they have teachers participating in the program. That is the first year math teachers will receive a salary equal to the average of the first and second year salary schedule, etc. At the end of five years, if the teacher chooses to remain in the school system they return to the regular salary schedule. Under this program school systems will have much stronger math personnel who are at the state of the art and at the lower end of their salary schedules.

Business and industry can help themselves by improving math instruction in the schools and to increase the size of the pool of math personnel that they can select from. In addition, they can participate in establishing training programs for teachers who will be joining their organizations.

Most young people have a great deal of altruism. Witness the participation in the Peace Corp. Although they may have ambitions to take their place in American business and industry, many are interested in strengthening the fiber of their society.

The overall impact of this program will be to strengthen math instruction by providing top flight instructional personnel who are at the state of the art. School systems will not need to be in direct competition with business and industry for these top flight personnel.

A Plan To Improve Science Education at the Elementary and Middle School Level

ELEMENTS OF THIS PROSPECTUS

(1) Elementary school science programs must be strengthened so that secondary school science programs need not be watered down.

(2) The breadth to science knowledge that must be utilized is immense. Interactive video will be the source of knowledge. The teacher will direct the learning process.

(3) Instructional units will be developed at all levels; kindergarten through middle school. The units will be such that each school district will have control of its own curriculum.

(4) Subject matter scholars, education developers, practicing school district personnel and production personnel will form production teams.

(5) Science units that are current and up-to-date will be constantly available to the school.

(6) Units will be transmitted/distributed from one source, thus reducing development costs.

(7) School district personnel will need assistance in utilizing this instructional mode.

Science education in the schools of the United States is at a dangerously low level. Increased concern about the quality of instruction has led the Congress to consider legislation to increase the number of qualified science teachers and to upgrade the skills of those persons currently teaching.

Much of the current concern in science education is focused at the secondary level. The importance of science education prior to secondary school is critical since it provides the foundation for subsequent scientific understanding. Because of the problems in science instruction programs in the elementary grades, and into the middle school, secondary students are not attracted to the study of science. Even when they are attracted, their lack of basic knowledge often requires secondary science programs to "water down" the instruction. This educational deprivation continues to take its toll on the students' progress.

The American educational community has tried several methods of strengthening science education, i.e., in-service workshops, fellowship grants, equipment purchases, curriculum development efforts, etc. Most of these efforts have been directed to the secondary level. Their success has been variable but none seem to offer promise for use in improving science instruction at pre-secondary levels.

The technological developments that we must understand and staff may hold promise for improving science instruction in our schools. In the past few years, a potentially powerful technology has been developed and refined. This technology is interactive video. Interactive video couples the technology of microcomputers with video recording. The hardware which is available offers a highly flexible and manipulable vehicle for instruction. While to some persons the claims made for interactive video may seem a replay of other lavish claims which were never realized for teaching machines, or educational Television, a closer inspection of the products which are available indicates that interactive video does offer new and exciting possibilities. Interactive video also capitalizes on the fascination with computer games.

It is proposed that an organization be put into place to produce and distribute interactive video instructional software. These instructional units will be at various levels from kindergarten through the middle school. The criteria for deciding upon which areas will be developed will be: importance of the concept or knowledge for subsequent scientific understanding; appropriateness of this delivery system for a particular concept; and usefulness of a discreet unit by teachers in their teaching. The units will be varied and discreet so that each school system can maintain control of its own curriculum.

This organization could be established under its own authority or it could be placed within the present authorized and funded educational laboratory and center program.

Teams of subject matter scholars, practicing school district personnel, educational development specialists and production personnel will be established to develop units. Once the units are developed, they will be continuously monitored and updated as appropriate. Evaluation data, new knowledge bases and the relationship of the units to each other will be utilized in this process.

Once stored in the main computer, the units of instruction will be transmitted via satellite and over land communication lines. The number that can utilize the system at one time will be almost without limit. Schools and/or individuals will subscribe to the system. Subscribers will receive access to the materials and will also help to detemine the units to be developed. They will also serve as the basis for the evaluative data which will be collected. Through the use of microcomputers, the units of instruction can be utilized in regular classroom settings, in learning centers or in the home.

The initiative outlined in this propesctus can provide materials which address the serious national need to improve science education in the United States. Other efforts to improve science education at the secondary level quite likely will be made. This project will increase the likelihood that such efforts will find a high level of scientific understanding on the part of students entering secondary schools.

HEARINGS ON MATHEMATICS AND SCIENCE EDUCATION
Part 2

MONDAY, JANUARY 31, 1983

House of Representatives,
Committee on Education and Labor,
Washington, D.C.

The committee met, pursuant to call, at 9:30 a.m., in room 2175, Rayburn House Office Building, Hon. Carl D. Perkins (chairman of the Committee on Education and Labor) presiding.

Members present: Representatives Perkins, Simon, Murphy, Kildee, Williams, Kogovsek, Coleman, Petri, Craig, Bartlett, and Packard.

Staff present: John F. Jennings, counsel; Nancy Kober, legislative specialist; and Richard DiEugenio, minority senior legislative associate.

Chairman Perkins. The committee will come to order.

The Committee on Education and Labor is concluding its hearings today on H.R. 30, the Emergency Mathematics and Science Education Act.

Last Wednesday, Thursday, and Friday we gathered some very profitable testimony on this bill. I certainly intend to make this legislation a priority of the committee this year.

H.R. 30 would provide funds to local school districts for elementary and secondary programs of inservice teacher training and modernization of mathematics and science instruction. At the postsecondary level, H.R. 30 authorizes congressional scholarships to encourage students to become mathematics and science teachers, and other activities.

The bill authorizes $300 million for fiscal year 1984 and an open-ended amount for fiscal year 1985.

I was glad to hear the President announce, in his state of the Union address, his support for a mathematics and science improvement program.

Mr. Secretary, we are anxious to hear your testimony, particularly any details of the administration's mathematics and science initiative.

First, let me congratulate you on your achievement in being able to support a bill. I don't know, it may be the first time that you have been able to make a breakthrough in initiating some new legislation in the Department. We welcome you here this morning, and we are delighted you are here supporting a very important piece of legislation. Nobody realizes better than myself, as chairman of the committee, that we must work with the administration to obtain results on this bill. Naturally, there is room for compromise on all pieces of legislation.

As I stated at the outset, we are pleased you are here supporting legislation. You go right ahead, Mr. Secretary. Without objection, your prepared statement will be inserted in the record. You proceed in any manner you prefer.

STATEMENT OF HON. T. H. BELL, SECRETARY OF EDUCATION, ACCOMPANIED BY GARY L. BAUER, DEPUTY UNDER SECRETARY FOR PLANNING, BUDGET AND EVALUATION

Secretary BELL. Thank you, Mr. Chairman.

I would like to submit my formal testimony for the record. I would like to just summarize and make some comments, and then maybe we can spend most of our time for questions.

The testimony that I have outlines the problem, gives data on the shortages of math and science teachers, and the problems we are facing there. I know in the hearings that you have heard a great deal about that. I don't want to be repetitive in that regard. So I will just make a few comments and then be prepared for questions.

I would like to begin by emphasizing just a bit why we have a shortage of math and science teachers. It will probably reinforce the points that I think have been made in testimony earlier in your hearings.

Not only are we losing teachers to high tech industries, because of better pay, there is a dramatic increase in the demand for teachers because we are raising the requirements for graduation from high school. School boards, State and local, are upping the number of units that you must complete in order to qualify for high school graduation.

We estimate that if you increased nationwide the high school graduation requirements in mathematics by one unit, you would, by doing that, create a demand for 34,000 more high school teachers. That in itself highlights the problems that we are having in meeting the need for math and science teachers. With the high school graduation requirements remaining where they are, we would be suffering from a shortage of mathematics and science teachers, without raising the requirements.

We need to dramatically increase the preparation that our high school youth make in these areas that are so related to the emerging new job demands as we go through this transitional period that we are in at the present time.

So I would emphasize that I feel that the problem is so acute and, with these requirements being raised so dramatically, we need to do something immediately to get more math and science teachers into the profession. That is related to H.R. 30, and also to the Senate bill sponsored by Senator Domenici. I will get into that for just a moment.

I don't believe, Mr. Chairman, that either of those two bills that I mentioned, the one on the Senate side or the one that you are sponsoring, notwithstanding the fact that I know there are some fine strengths in them, are designed at the present time to take advantage of an opportunity that we could have to immediately—by immediately I mean within the span of a year from enactment—see a dramatic increase in the supply of teachers. The reason that I think that we can get a more immediate response is because at the same time that we are raising the requirements for graduation from high school in the areas of mathematics and science, we are going to be decreasing the demand for teachers in some of the elective areas—sociology, political science, psychology, and other areas.

Assuming that there is going to be a shift in enrollment from many of these areas over into required mathematics and science areas, we are going to have an increase in demand for math and science teachers. At the same time, we are going to have a decrease in need for teachers in other subject areas, because as students shift their enrollment from one area to another, there is going to be a shift in the numbers of students in classes.

I think that we can take advantage of that if we structure our legislation to be responsive to it.

In addition, with the unemployment that we have in the country right now, there are many individuals with college degrees, not in education and not in teaching, but have 4 years of college. With a year or less of study, many of them could prepare to become high school mathematics, physics, chemistry, or biology teachers, if we can provide the assistance for them to do so.

The bill that the administration will be proposing will provide scholarships to individuals who want to be high school math and science teachers; individuals whom the local school board members have recruited. And we would provide financial assistance for them to attend higher education institutions for a year or, at the most, a year and a summer school, and then move into the math and science teaching ranks and help to fill this big demand.

By concentrating on teachers who have lost their job during this recession, who have college degrees, and who have an aptitude and an interest in becoming teachers, and who, because of this aptitude and interest and other qualities, would be good teachers, by concentrating on these individuals immediately, we feel that we can begin to increase this supply.

We think that the legislation that is considered by the Congress ought to concentrate on teacher demand. Therefore, I would emphasize to the committee that it would be good policy for us in legislation that is enacted to focus on the need for math and science teachers.

My feeling is that S. 248 and H.R. 30 don't concentrate enough on the immediate problem. I would concede that there are some long-range opportunities that the bills provide. But I would emphasize, as I read the information about the demand for more teachers, because of the increase in high school graduation requirements, that we need an immediate response, and what is more, we can capitalize on that if we will focus our legislation in a way that will do that a bit more effectively than either of the bills do.

I would also comment that I think when the budget is released this afternoon you will find that the provision in your bill, Mr. Chairman, that requires a certain level of appropriations for chapter 1 won't be necessary.

I understand the priority and the concern for that. You will find when our budget is released this afternoon that we have also given a priority to this area of the program.

I think the scholarship provisions in H.R. 30 are good provisions. As I say, Mr. Chairman, I would like to see more emphasis on the immediate opportunity. Those students that are now in college, preparing to be math and science teachers, are in the pipeline. Now, there are not enough of them, I would concede that. But as we wait to award scholarships to college freshmen and seek to see them enter the teaching ranks 4 years from now, we are not going to be able to cope with the immediate problem.

Those are some of the comments that I have on the legislation. And I would like to see those provisions strengthened.

I should say for the record, Mr. Chairman, that as we look at the budget we would like to see a smaller demand on appropriations than either of the two bills provided. Possibly as our economic recovery gets underway, we would be able to afford the more ambitious legislation. But our legislation, Mr. Chairman, concentrates on the teacher supply immediately.

Those are my comments. I am ready for questions.

[Prepared statement of Secretary Bell follows:]

PREPARED STATEMENT OF HON. T. H. BELL, SECRETARY OF EDUCATION

Chairman Perkins, Chairman Simon, and Committee members. I appreciate this early opportunity to appear before the joint Subcommittees on Elementary, Secondary and Vocational Education, and Postsecondary Education, to discuss science and mathematics education. I believe—and I know you share this view—that there are currently few topics in education which are more deserving of attention than this one.

Certainly quality in education is a concern in every field of study, and there is a pressing need to increase academic excellence at all levels. That is why I have created a National Commission on Excellence in Education to focus on the entire range of problems which face American education. The Commission's report will be published this Spring.

But science, mathematics, and technology have a very special importance in this country. They comprise one of the cornerstones on which our success as a nation is built. Our economic strength, our military strength, and our health and well-being depend to a very large degree on the fruits that modern science and technology—much of it developed by our own citizens—have brought to us. To maintain our strength and, indeed, our independence, we simply cannot afford to let our considerable skill in these fields degenerate. Yet, it appears we are doing just that.

The President, in his message last May to the National Academy of Sciences symposium on science education, and again last week in the State of the Union address, clearly and forcefully articulated this concern, saying that the declining condition of science and mathematics education has become serious enough to compromise the nation's future ability to develop and advance our traditional industrial base, and to compete in international marketplaces.

The problems are particularly severe at the secondary school level where there is a growing shortage of qualified science and mathematics teachers at the very time when many States and localities are trying to raise standards and increase enrollments.

Recently, for example, 43 States reported a shortage of math teachers, 42 reported a shortage of physics teachers, and 38 a shortage of chemistry teachers.

Yet, the supply of new science and mathematics teachers is dwindling:

According to data from the National Science Teachers Association, during the past decade there has been a 79-percent decline in the number of individuals preparing to teach mathematics, and 64-percent decline in the number of individuals preparing to teach science.

As our current science and mathematics teachers retire or, in too many instances leave teaching for other fields, it is very, very difficult to find qualified replacements for them. The problem will grow into a crisis because of another trend in education: State and local school boards are raising high school science and math graduation requirements. Also, twenty seven State universities have recently increased entrance requirements or have study commissions reviewing admissions standards and most of these requirements are in science and mathematics. For each additional course required of high school students, we will need tens of thousands of additional teachers. We do not have enough science and math teachers now.

Furthermore, our requirements for high school graduation are too low.

For example, a 1980 survey showed that only nine States required two years of mathematics and only one State required three years.

Other data show that only 38 percent of seniors report taking 2.5 or more years of mathematics, and nearly 5 percent report taking no math at all. Only one fourth report taking 2.5 years of more of science, while 8 percent have taken no science courses.

As boards raise the requirements to increase students' competence in mathematics and science, the need for teachers will expand at an alarming rate.

Many of you here today have heard a very detailed discussion of these problems during the last few days, and I don't think it is necessary for me to describe the situation at greater length. Clearly, the problems are important ones. America is still the technological leader of the world, but as the President observed in his State of the Union address, "We must keep that edge, and to do so we need to begin renewing the basics, starting with our educational system."

In response to these problems, dozens of bills were introduced in the last session of Congress related to science and mathematics education. More recently, you, Chairman Perkins, Representative Goodling, and others, have introduced into the 98th Congress H.R. 30, the "Emergency Mathematics and Science Education Act." I am pleased that you are expressing interest in this important area so early in this session, and, through these hearings, are focusing the attention of the Congress on it.

What is most urgent, in our view, is the necessity to forge an effective partnership with States, local education authorities, and private industry, so that each can do its part of the job. The Federal role must be a limited one—and not only in financial terms.

It is States and localities which set graduation requirements from high school—not the Federal government. I feel strongly that these requirements need to be raised in many districts if America is to maintain its technological edge. I applaud the efforts of superintendents, principals, school board members, and others who have recognized this early on and have set a standard others would be well advised to follow.

It is leaders from business and industry—not the Federal government—who ought to be the first to offer assistance to educators who want to understand and implement an educational program which is appropriate for a rapidly changing world of work.

It is in this context that the Congress is considering new legislation. H.R. 30 authorizes a very wide range of activities. Among others, H.R. 30 contains provisions addressing the matter of teacher shortages in science and mathematics, and the need for in-service training for current teachers.

In addition to teacher training, H.R. 30 would provide support for a variety of other activities. These include: curriculum development in science and math; the use of new technologies, such as the microcomputer; improving employment-based programs in community colleges; research and development in science and mathematics education; and the acquisition of new scientific equipment in postsecondary institutions. Many of those activities could be supported with funds from the Chapter 2 education block grant. With our NIE budget and our NSF budget we can effectively address research problems and concerns. As you know, I have already set a high priority in ED on research and related activities involving the use of technology to improve teaching and learning. More importantly, we need to keep in mind that we do not have unlimited resources at our disposal. Given the continued need to hold the line on government spending, I believe it is essential that any new Federal funds be targeted on only a small number of concerns, so we can maximize their effectiveness.

On the matter of teacher shortages in science and mathematics, where we agree on the priority need for Federal action, H.R. 30 proposes creation of Congressional scholarships to train new science and mathematics teachers. The scholarship mechanism seems appropriate. However, if we hope to substantially increase the supply of teachers, we must look beyond those now in college preparing to teach in these fields and make use of currently available talent focusing on people in other fields. We should, as I see it, concentrate our limited Federal resources to meet the demand as quickly as possible. This can best be done by utilizing teachers who are not needed in the field for which they are now trained. We should also look to others with college degrees who are not in teaching. I am thinking of retired military personnel and the recently unemployed who might have an aptitude and interest in teaching high school mathematics and science.

The bulk of the money that would be authorized by H.R. 30 does not, in my view, concentrate sufficiently on the teacher shortage problem. The classrooms are there. The budgets needed for textbooks and other supplies are included in State and local finance formulas. What we need most urgently are teachers with strong academic preparation to teach such subjects as physics, chemistry, biology, and mathematics. The teacher supply problem requires our immediate attention. I suggest that we concentrate our efforts on increasing the number of teachers prepared to teach science and mathematics in our high schools.

As the President announced in his State of the Union address, the Department of Education is preparing to submit to the Congress by the end of this week proposed legislation to improve the quality of secondary level science and mathematics education. This bill focuses on what I believe is the most critical element of the problem—the growing shortage of qualified science and mathematics teachers at the secondary level in grades nine through twelve. In brief, the program would work as follows. Funds will be allocated to the States by formula to be used for scholarships for individuals not currently qualified to teach science or mathematics. Up to $5000 may be used for each scholarship. Eligible individuals must already hold a bachelor's degree, and must be able to become qualified to teach science or mathematics within one year. Prime candidates for these scholarships include teachers currently qualified in fields other than science or mathematics, and individuals with college degrees and interest and aptitude to teach high school math and science, but who need the academic preparation to do so. It is our intention to assist a large number of such individuals, and train them quickly. Our schools need these qualified teachers soon. That is why we would like to limit participation to individuals who are not now training to teach mathematics or science and who can qualify within one year.

In addition to the Department's initiative, the National Science Foundation is proposing to support two activities in pre-college science and mathematics education. Under the administration's proposal, the National Science Foundation will be supporting:

Assistance to community-based efforts for in-service training of science and mathematics teachers at the junior high and high school level. Such training is needed because—from computer science to space exploration to ecology—there have been profound changes in mathematics and the sciences in recent years.

We would like to see much greater recognition given to the many dedicated science and mathematics teachers currently working in secondary schools, often at salaries below what they could be making in business or industry. The NSF, with assistance from the Department of Education, proposes to operate a program of awards for teacher excellence which will identify outstanding science and mathematics teachers in each of the 50 States. A few months ago I was delighted to be able to honor as Teacher of the Year an outstanding individual, Bruce Brombacher, who teaches mathematics in the State of Ohio. We really ought to be doing more to let the Nation know that there are such talented individuals working in the schools, right now.

These programs which I have described as part of the administration's fiscal year 1984 budget reflect this administration's belief that there is an appropriate Federal role in science and mathematics education. Even with the budget restrictions under which we must labor in today's economy, we consider this problem of sufficient magnitude to justify an expenditure which we hope will be assisted by funds from State, local and private sources.

In conclusion, I would urge you to concentrate on the most urgent problem. That problem is the critical teacher supply situation in these fields. Let's target our limited dollars there so we will get a maximum return. And let's look for results as quickly as possible. We must increase our pool of qualified teachers. Only with additional qualified teachers in mathematics and science can school boards raise local graduation requirements and enable the Nation to maintain its technological edge.

Thank you, Mr. Chairman, for this opportunity to express my views to this Committee.

Chairman Perkins. Thank you very much, Mr. Secretary.

You did not make any reference in your statement to any specific level of funding for your new proposal. Could you tell us how much you would propose to spend?

All last week Congressman Goodling and myself were criticized by educational associations and organizations for only proposing $300 million. They all said that was not nearly enough.

How much are you suggesting?

Secretary **Bell**. Our budget is embargoed until noon today. But I think to further our conversation and to let those that were criticizing your bill contrast it, we are proposing a $50 million piece of legislation. Bear in mind, it concentrates on the teacher supply problem only. And your legislation and H.R. 248 is broader than that.

We think our proposal more accurately reflects the very serious fiscal picture that we face, and if we are going to meet the other demands in the Department of Education's budget for student aid, for aid to the handicapped, for impact aid, for chapter 1 and the other programs, we are hard-pressed to find $50 million. Given the rigors of the budget and the total dollar amounts that I had to work with, $50 million was the most that I could earmark to go into this. Because of that, I would emphasize to you that our proposed bill will be narrowly focused on the teacher supply problem. And I would like to talk to that just a minute, if I may.

When you teach mathematics, for example, you need a classroom and a good teacher who knows the subject matter, who knows how to teach it, and the textbook. You don't need a lot of other material for mathematics.

Now, I would emphasize in the laboratory sciences there would be a need for that. But as we look at the Federal, State, and local partnership, we felt that if we could emphasize meeting this teacher supply problem, that maybe State and local budgets in their finance formulas could provide the other means.

We don't think there is going to be an enormously large demand for classrooms or for instructional supplies, and particularly that is the case with respect to mathematics. Because of that, and because of the harsh realities of the budget, we concentrated on teacher supply. Our proposed bill focuses on that. The proposal that we have would limit the scholarship, give priority scholarship to those that can qualify and be ready to teach within a year plus a summer school.

This approach will give us immediate turnaround, immediate response to the need that we are talking about.

Chairman **Perkins**. Now, we haven't seen your budget proposals for fiscal year 1984. It was delivered to my office this morning just as I was leaving. I would like to ask you if you are cutting any of the current programs, such as chapter 1, if you are cutting compensatory education or handicapped education.

Could it be said that you are proposing funding for this new bill at the expense of the disadvantaged children or the handicapped children?

Secretary **Bell**. That is a difficult question for me to respond to, not because I am concerned about the answer, Mr. Chairman, because I think you will be pleased with the response, but public discussion of this is embargoed until noon today.

I think generally speaking, with some exceptions and some changes in priorities, that you are going to find level funding in most of the areas that you are referring to.

One of the opportunities that we had in putting our budget together, Mr. Chairman, was the fact that we have had a decrease in the demand for interest on the student loan program, a dramatic decrease on that huge amount of capital out there. And so we have been able to fund the same loan program for 1984 as is funded for 1983 with a decrease of a little better than $1 billion.

You will find the other program areas that you talked about—handicapped and disadvantged—fairly levelly funded in our proposed budget. I know that is a contrast with last year's proposal in that regard.

We think you will be pleased with the Department of Education budget. You may take some exceptions to some of our priorities. But by and large, you are not going to find the disagreement that we had last year. I had better not go into any more detail.

We have a press conference and a release at noon today.

Chairman PERKINS. Now, your proposal deals with attracting new people to teaching or retraining current teachers to become mathematic and science teachers. But how are we going to deal with another part of the problem, namely, keeping current math and science teachers? These people are being lured away by higher salaries in industry, which we all know. How are you going to deal with that problem—industry coming along and picking these good teachers up after we get them in the schools?

Secretary BELL. It is a very vexing problem and I acknowledge that it is, Mr. Chairman.

Chairman PERKINS. You did not deal with it in your statement, I note.

Secretary BELL. No. I would like to talk to that a bit.

First of all, it ought to be said for the record the fixing of the compensation of teachers is, as we all know, the school board's responsibility. I don't think we are ever going to cope with the problem of losing teachers to higher paying jobs until we change considerably at the State and local level our approach to compensating teachers.

I contrast the way that we pay our teachers on the elementary and secondary level with the way that we compensate higher education faculty. As you know, we have academic rank, you can work your way up to a full professorship, we have endowed chairs, and distinguished professorships. And in contrast to that, in elementary and secondary education we have a universally accepted approach of a single salary schedule, and the factors that fix a teacher's salary are the amount of college credit that has been earned and the number of years of experience. I have been suggesting when I have had opportunities to talk to local school boards and superintendents and the State legislators and Governors, that we create a system that learns from what the higher education has established.

I have suggested that we create a master teacher position in the elementary and secondary schools, to identify those persons that are high priority to us, that are tremendously outstanding teachers, and then compensate them beyond the salary schedule.

That is what they do in higher education. And I think that until we do that, we are not going to be able to cope with that problem. It is when the school superintendent has the flexibility that is necessary that we are going to be able to do that.

Now, I recognize that another way that could be done would be to just raise the salary schedules of everyone way up there, but as we do that, we are going to have an enormous demand for money that I don't think State and local taxes can afford to meet. That keeps us constantly paying people on the basis of experience and college credits earned.

I think we simply have to depart from that. I think we need to do it by involving faculty on the elementary and secondary level in peer review work, just like the faculty has a peer review when they decide who gets advanced to the rank of full professor in higher education.

Now, there may be another approach to this. It may be that we will have to find opportunities to pay on the basis of scarcity and demand and competition, in addition to the master teacher idea. But I think if we are going to attract the kind of talent that we need to attract, that we are going to need to make quite a change in our approach to compensating teachers. Until we do that, Mr. Chairman, I think we are not going to be able to do the job that we ought to do in meeting the drain that I know is there in teachers.

Mr. KOGOVSEK.. Mr. Secretary, the chairman had to go down to the White House this morning for a meeting with Mr. Stockman and other people, so he asked me to chair the meeting for the time being.

Secretary BELL. Mr. Chairman, I have neglected to introduce my colleague, Dr. Gary Bauer, who is in charge of our budget and evaluation. He is Deputy Under Secretary for Planning and Budget and Evaluation. I am pleased to have him here at the table with me.

Mr. KOGOVSEK. Doctor, welcome to the committee.

Mr. Secretary, the chairman had said previously that he was receiving criticism from several educators because of the fact this bill only talked about $300 million. You are indicating that $50 million is the figure that you are looking at. What does $50 million buy us—how many teachers?

Secretary BELL. $50 million would increase the supply of teachers by about 7,000 a year if we awarded scholarships in the area of around $5,000.

In addition to that, we would hope that by focusing on this, the State and local levels would pitch in. Although we are not requiring matching, we would hope their effort would reflect this a bit, and that we could up that number by maybe threefold. That would be what our proposal provides.

Mr. KOGOVSEK. Approximately how many school districts do we have in the Nation right now?

Secretary BELL. There are 16,000 school districts in the United States.

Mr. KOGOVSEK. Your $50 million doesn't even get us half a teacher per school district. This is an ongoing program you are talking about, $50 million a year for several years?

Secretary BELL. Our proposal is 4 years. I think the chairman's proposal, H.R. 30, if I am accurate, is a 2-year emergency program.

Mr. KOGOVSEK. So when you are talking about approximately 16,000 school districts, $50 million buys us about 7,000 teachers for the first year. And I assume that you would target these teachers to the highly populated areas.

Secretary **Bell**. Yes. Our proposal would allocate the funds to the State education agencies, and they would have discretion to try to allocate them where the demand is.

I would also emphasize that the $50 million proposal doesn't include funds that will be spent by the National Science Foundation. The administration has two other initiatives that are in the National Science Foundation appropriation. This element has more of the long-range approach that I know is reflected in H.R. 30.

So I would not want to leave the impression that the $50 million is the totality of our proposal. The other budget items are over in the National Science Foundation.

I apologize for the awkwardness and the release date on the budget, because I think if I could talk to that more, and if I had a little freedom to talk about the Science Foundation budget, it would be helpful here. I don't want to alienate my colleagues over in NSF by airing their budget but I should tell you, so we are totally accurate and candid about it, that there are two other initiatives over in the National Science Foundation in addition to ours that concentrates on teachers.

Mr. **Kogovsek**. I appreciate that, Mr. Secretary. We are just about 2 hours away from your embargo timing. I would like to lock the doors and not let anybody out and we could talk about it. But probably we better not do that.

Let me see if the gentleman from Idaho has any statement or questions at this time.

Mr. **Craig**. Thank you very much, Mr. Chairman.

And, Mr. Secretary, it is good to have you before the committee.

Let me express Congressman Goodling's regret. He is back in his district and committed, and could not be here this morning for your testimony.

I think all of us are pleased to see the emphasis expressed, not only by you, but by the President in his state of the Union message, as it relates to math and science and the national concern that is developing over this area of deficiency in our education system.

Of course, we have taken several days of testimony on H.R. 30. Although some of us are concerned about areas of it, it has received a share of criticism, as has been mentioned by the chairman, because of the volume or the level of funding. I guess that is because the community at large out there thinks we ought to solve this problem now, and you do that by billions of dollars, and it is done overnight.

I suspect that is not the case, nor can it be, if we are looking at some long-term strength and stability to solving the problem. I think all of us would like to solve it immediately, but recognize the reality of doing so.

In all of your testimony, a couple of things come to bear that are a concern to some of us on this committee; two areas specifically. Your proposal seems to be more targeted for an immediate response than does H.R. 30. I think that has been a concern of mine, as it relates to H.R. 30 and its rather broad approach, instead of the immediate targeted approach which will get us some response, and get it in the relatively near future.

I see your proposal talks of that. I will be anxious to see it in full and how that targeting can come about, along with the National Science Foundation and its targeting.

Can you respond to that?

Secretary **Bell**. Yes. Our bill should be up here within 1 week, and then you will be able to see a bit more how it is structured.

You are right, Mr. Craig, that it does concentrate on teacher supply problem. And your proposal, if enacted by the Congress, would only give scholarships to those whose analysis of their situation would make it possible for them to enter the teaching ranks within a year or a year plus a summer session.

We think that will give some satisfaction to this situation. We would hope that it would be accompanied by greater efforts on the State and local level, although we are not requiring a matching.

Mr. **Craig**. To guarantee the kind of targeting you are proposing, primary and secondary, what type of guarantee or requirement will there be to insure that individuals who receive these scholarships do, in fact, teach or are not moved away immediately by business with the offer of $10,000 or $15,000 more yearly salary, which is happening now?

Secretary **Bell**. We are still in the process of trying to determine whether a scholarship awardee ought to be required to teach for *x* period of time as a condition of receiving that.

I wonder, Dr. Bauer, if you could talk to that question a bit.

Dr. Bauer has been working on this specifically, and it is still in the concept stage as we pass proposals back and forth with OMB.

Dr. **Bauer**. To reiterate what the Secretary said, we still are drawing up some of the specifics of the legislation. But we understand the problem you are referring to.

Our inclination is to have some sort of requirement where LEA's have an agreement with the teacher that the teacher would teach for a specified period of time before they would be eligible for the scholarship money. So although the details have not been worked out, our inclination is indeed to include that in the legislation.

Mr. **Craig**. That is a concern I think all of us would have. I am not saying there are those who would take advantage of the scholarship to increase their ability only to move into private industry, but that is a reality we have to face if indeed we are going to address the problem at the secondary level.

I noticed in your statement that you continually refer to junior high and high school or secondary levels, and that if we are really to build the kind of base that this country needs, and the desire on the part of young people to advance themselves in math and science, we have to start at a younger age. I notice your program does not address that.

Secretary **Bell**. We agree, Mr. Craig, that we ought to be strengthening math and science instruction in the elementary school. Our proposal doesn't touch that. We think we have an obligation but we think local school boards are also sensing that obligation to strengthen those efforts.

We would emphasize that we think that is a State and local responsibility. Surely a Federal concern. But, given the fact that we are only talking about a $50 million program, we wanted to target it. And the whole theme of our proposal is targeting specificly on the secondary problem. Our proposal will be limited to the senior high school: 9th, 10th, 11th, and 12th grades.

I wouldn't want to imply that we don't think we ought to have strengthened instruction on the intermediate, junior high school, or the elementary school level. On the contrary, I just think it is important that we do that. With all the pressures on our budget, and not wanting to cut some of these other priorities that the chairman referred to, we had to limit what we could do to $50 million. So it is very selectively targeted in that regard.

It assumes that State and local education agencies, State legislatures and local school boards are going to be also concentrating in these areas, and they are going to be dealing in priority instruction there. But it isn't as broadly based a piece of legislation as H.R. 30.

Mr. **Craig**. Is there any consideration in the Department at this time, and I think you referred earlier to the fact that this would be block granting and not matching funds, for local units and State units to place greater consideration on the lower levels if in fact the Federal Government is going to place a priority on some immediate response at the secondary level?

Is there any contribution in the Department now of blending this approach and, in fact, creating some incentive at the State and local levels for doing it on their own in those areas?

Secretary **Bell**. We have talked about that. We talked about some kind of matching where, if we concentrated on the upper level, that there would be a sort of a reciprocal effort in these other areas. We abandoned that because of our belief that we should not be pressuring State and local units on their priorities, and our feeling that most local school boards, State legislatures, and State education agencies are highly aware of this problem. We think we are going to get a response there without our structuring a requirement as a condition for receiving aid, you must do thus and so.

In addition to that, we don't think the $50 million is a large enough incentive in that regard.

I should emphasize more than I did in my initial statements that there are some provisions that are long range in the National Science Foundation proposals, and there are two initiatives there where the administration has also come up with more money. So I would not want the committee to have the impression that the administration's initiative is limited to the $50 million program that I am talking about. It is broader than that, but the other responsibility is over in the National Science Foundation.

Mr. **Craig**. Fine. Thank you very much, Mr. Secretary. I think we will all look forward to your proposal and recommendation when it comes to the Hill. This is an area that this committee is going to obviously place high priority on this year, and we will look forward to your assisting us.

Thank you.

Mr. **Kogovsek**. I thank the gentleman.

The Chair now recognizes the gentleman from Michigan, Mr. Kildee.

Mr. **Kildee**. Thank you, Mr. Chairman.

Thank you, Mr. Secretary, for your testimony. You know you are always welcome here, we always have some good exchanges. You are informative and always a gentleman.

You mentioned that the administration intends that its proposal be funded at $50 million. Is that $50 million only for public schools?

Secretary **Bell**. No. There would be a provision for private school participation also. The money, Mr. Kildee, would flow to the State education agency, and they would have the opportunity and the requirement that they allow private secondary schools to participate where they also have some teacher shortage problems.

Mr. **Kildee**. From my point of view I would like to see much more in there. As you have been told by some of the other members, earlier testimony before the subcommittee indicated that even $300 million would not be adequate to meet the need in this area. If the $50 million you propose is for both public and nonpubic schools, then it seems even a more inadequate figure to take care of what I consider a very urgent need.

Secretary **Bell**. If I were free to discuss the National Science Foundation aspects of this, where they have certain other incentive type proposals, two other initiatives the administration has, I would do a better job of pushing the $50 million appropriation, at least to describe the totality of the program we have proposed.

I am reluctant to discuss the NSF budget before release time today. And certainly, out of courtesy to the Director, I ought to not be in here announcing his program. But the total program includes the National Science Foundation. Even at that, you won't find a $300 million effort. One of the problems we have faced is the budget realities and the fact that we had to work this program within the confines of a finite budget allowance that we were given. That restrained us considerably in this regard. That is why our proposal is so highy targeted and focusing upon the teacher supply situation.

Mr. **Kildee**. You have heard me say this before, but I wish that the budget constraints imposed on Cabinet departments such as yours would also apply to the five-sided building across the river.

I would like to see a more equal application of that philosophy of fiscal restraint. I think that your Department has borne an undue burden of that restraint in the last 2 years, and I hate to see it so unequally distributed.

Secretary **Bell**. I think you will find our funding level, when it is released at noon today, will be quite adequate.

Mr. **Kildee**. We had good news in Washington yesterday.

Secretary **Bell**. I think this can follow right on with that great Redskins victory.

Mr. **Kildee**. I yield back the balance of my time. Thank you.

Mr. **Kogovsek**. The gentleman from Wisconsin, Mr. Petri.

Mr. **Petri**. Thank you.

Mr. Secretary, thank you for testifying.

I have one or two questions about how this program is proposed to be organized. Is the $50 million a year contemplated for more than 1-year scholarships?

Secretary **Bell**. Yes; our proposal would be $50 million a year for 4 years.

Mr. **Petri**. And the scholarships would run for 4 years or 2 years or 1 year?

Secretary **Bell**. No. Our proposal would limit the scholarship to individuals who can qualify to teach within 1 year plus summer school.

Now, the reason for that is that we want to get an immediate response. We are increasing the demand for teachers by raising the math and science graduation requirements. At the same time we are doing that we are decreasing the demand for teachers over in other areas, because they will be moving students over into this higher priority area. So we would have a scholarship that would retrain teachers that are now there.

Incidentally, this is being quite effectively piloted, Mr. Petri, up in Philadelphia, and we have studied it there. So we think it has a lot of potential.

It would also make the scholarship available to someone who is not teaching, but who has a college degree and would like to become a high school math or science teacher. And our proposal limits the availability, as I indicated to Mr. Craig, to 9th, 10th, 11th, and 12th grades.

We are trying to focus right on the problem. We would like to see a turnaround in that supply by the fall of 1984. And so, as we talk about the fiscal year beginning this coming fall, by the following year we would like to see some results in the supply of teachers coming out of the pipeline. Now, if we spend our money on college freshmen we are going to be way down the way before we meet this need.

The State of California, the State Board of Education, as Mr. Packard can tell you—he is a former school board member from out that way—has just dramatically increased the requirements in mathematics and science. This is our most populous State. So we have an immediate problem that we want to try to focus on.

My criticism, notwithstanding the strengths that I know are in H.R. 30 and S. 248, we think the value of our proposal is that it focuses in a narrow-ranging way upon the immediate problem, and limits the recipients in a way that will get us immediate results. The more long-range part of the program is over in the National Science Foundation budget.

Mr. **Petri**. Is there going to be any requirement or has thought been given to a provision that if people are not teaching math or science 5 years after receiving the scholarship or some other period, that they repay the scholarship?

Secretary **Bell**. We have really agonized over that. Our philosophy is that we ought to be helping and strengthening every way we can the local and State education agencies and boards. And we want to refrain from Federal money pressuring their priorities. We looked at requiring matching. And we decided, knowing what the feelings are about that out there, that we would refrain from requiring matching. We thought about putting in some requirements, like in order to get this money the school district had to commit teachers to teach for *x* years.

We thought, well, we had not ought to get into that, that is their business, and if they want to set those requirements on their levels, they will have discretion to do that, as they grant it. I would hope that they would do it. But I wanted to refrain from doing that. I have been a local school superintendent for a number of years, and served in three different States, and I did not appreciate that kind of Federal mandate and dictation.

But as you look at the problem, you get anxious about it, you are tempted to put some of those wedges in there. And we decided not to yield to that temptation. We think we are right in that regard.

Mr. **Petri**. Now, as I understand it, the money is going to be allocated to the appropriate State agencies on some sort of a formula basis for them to parcel out according to some guidelines contained in the legislation and probably also supplemented by regulation which is a fairly normal administrative approach at the Federal level. I understand the scholarships may be in differing amounts, and I cannot possibly imagine what the overhead would actually be.

Say it is all spent on scholarships of $5,000. You are talking about 2,000 scholarships per State per year. And that is one or two or three a county. It is pretty small. And you are talking about lots of rules and regulations, someone is going to have to sit there and try to administer the new program.

What is your reaction to doing this the way General Motors or other people in the past did it when they wanted to help out programs like this, getting the Educational Testing Service or some other organization already set up that administered scholarship type programs on contract, do this on a national basis and save on administrative overhead and make sure it is actually reaching the type of people that you want it to reach rather than simply helping to bear the overhead burden of already overpressed State governments.

I am sure we will discover lots of overhead in a program like this, because there is a learning curve in the best of times, and also a lot of pressure. They are going to have people they want to keep on the payroll, and allocating time to this program will be one way of doing it.

I think you will have a very high administrative overhead in a $50 million domestic program that dribbles money out in such a small scale to each of the 50 States, given the learning curve that they are going to have to go through, if it is inefficiently administered.

Secretary **Bell**. We discussed all of those matters. Our proposal will limit the amount of Federal money that can be used for State administration to 4 percent. So we will have a limit on the administrative overhead as far as we are concerned.

The reason I don't think that there is going to be all that additional cost is because it is focused on those that employ teachers. The State departments of education, all 50 of them, have a teacher personnel office now, where they license and review and participate with the local school districts in teacher personnel activity.

I am confident that the 4 percent, since it would go to that existing teacher personnel office, will be adequate. And I have talked about that with some personnel officials. So we think we can limit it to that. We thought of going to some entity like the Educational Testing Service, but we think we will create too much distance between them and where the actual employment takes place.

We think if we put the scholarship in the hands of the local school board, working with the school superintendent, that they are able to recruit a teacher and award them this scholarship—keep in mind they will maybe be able to qualify for some of our student financial aid as they go to school for a year. As they award the scholarship, we hope without our dictating to them, that the superintendent of schools and the school board will have an agreement with scholarship recipients that they are going to prepare themselves in a year, and by the next fall are going to be back teaching high school algebra for us.

That is the way we anticipated it, and we thought we would not have that connection with the actual job, the actual contract. We hoped that some of them would sign them up before they went. That is what I would do if I were a superintendent.

Mr. KOGOVSEK. The gentleman's time has expired.

The Secretary has to be at budget briefings, I would assume, relatively soon. I would like to get a couple of more people in.

Mr. Harrison from Pennsylvania.

Mr. HARRISON. Thank you very much.

I didn't have the honor to be here in the last Congress, but the staff tells me this is the first time in the 3 years you have come here that you have been able to propose a program instead of rescinding or cutting a program. I congratulate you on that.

Mr. Secretary, I see in your statement an indication that the type of people who are likely to accept the scholarships under your program are retired military officers and the recently unemployed. Are you referring there to people coming out of business and industry who have been laid off because of the economic conditions?

Secretary BELL. I think they would be the lesser number of those participating. I think most of our scholarship recipients will be existing teachers who have good qualifications, who have been successful, and have been teaching in other subject matter areas. If there has been a decrease in the demand for their services because of raising high school math and science graduation requirements, and we are raising the high school graduation requirements, students are going to be enrolling in lesser numbers of elective subjects.

So we think most of the recipients of those scholarships will be those individuals. But we do not want to limit it there. We thought if there were some promising person whose personality, aptitude, and ability and the interviewing school district felt had great promise to come and teach for them, they could also be included. But I would not want to give the impression that our proposal is concentrating on retired military and unemployed people.

On the contrary, I think it is going to be currently employed teachers receiving most of them, and just a few of them in other areas.

Mr. HARRISON. Are you suggesting that people who are finding their history and English classes underpopulated are going to become math and science teachers with 1 year training under your program?

Secretary BELL. I don't believe that there will be many from those subject areas. I think we are going to find them in areas like sociology and political science and psychology.

I would not want to imply that all of them can become math and science teachers overnight. If you already have your student teaching and other subject matter, and if you need to beef up your competence in mathematics, I would argue that three-quarters plus a summer session or two semesters plus a summer session would accumulate enough hours so that at least you could be on the threshold level within that time to begin to teach.

Then we would anticipate that the more experienced faculty could teach some of the more advanced placement courses, chemistry for example, and the newcomer with maybe 30 hours of chemistry could teach the introductory course there.

Mr. **Harrison**. You are really suggesting that in a year and a summer school a sociologist will be qualified to teach chemistry at any level?

Secretary **Bell**. I don't think they will be able to do it if they have had zero chemistry. If they have had a couple chemistry courses and have math background, and there are those that have had that amount of preparation, then I think they are going to be able to at least get to the entry level by then.

Mr. **Harrison**. One last question. Wouldn't you think that these are precisely the people who would be most inclined—should a job in industry come along—to take it and get out of this unfamiliar teaching pattern of having shifted from some other discipline into science and math?

Secretary **Bell**. After they have developed their competence, say in mathematics, they could well be snapped up into the computer industry. I acknowledge as we wrestle with this that this is a serious problem. As I said, I think school boards have to do something about the way that they compensate teachers if we are going to be competitive.

Mr. **Harrison**. Thank you, Mr. Chairman.

Mr. **Kogovsek**. I thank the gentleman from Pennsylvania. I think he makes what to me is a valid point. We might be under your proposal increasing the outflow, Mr. Secretary, of people who are tired of teaching in a certain area, and after 15 or 20 years see a chance to pick up a scholarship and move to another area and may want to do that as opposed to this bill which would at least require the whole 4 years.

Secretary **Bell**. I would hope that the local school authorities would have the good judgment—they have to have it because it is their responsibility—not to employ tired or burn-out teachers. I think they will be quite discriminating about that. I hope they will.

Mr. **Kogovsek**. The gentleman from California, Mr. Packard.

Mr. **Packard**. Thank you, Mr. Chairman.

I am particularly grateful to have the Secretary come and testify here.

The whole problem does not necessarily lie in a shortage of teachers but also in the quality of teaching that takes place by the existing teachers of math and science.

Is there any plan in either your proposal or in the rest of the Science Foundation program where there would be an inservice training of teachers?

Secretary **Bell**. There are aspects of this in the National Science Foundation proposal. As you know, Mr. Packard, being a former school board member for a considerable number of years, that is a very important element of upgrading the quality of instruction, and it will be in math and science.

Mr. **Packard**. In the out years it is projected that there may be a declining enrollment and, therefore, maybe a lessening of the need for an increase in the number of teachers—at least to the extent that might appear necessary at this time.

Would this have an influence upon your overall proposal in terms of the declining enrollment projections?

Secretary **Bell**. We think that the life of this program being 4 years, will probably see us through this transition period. If we find because of enrollment declines—and I acknowledge there are some projected declines—that if it is not necessary we may not need the 4-year approach. But right now we anticipate that we would at least start out anticipating that.

Mr. **Packard**. One last concern that I have is with the timing of the proposal. I understand from the hearings on H.R. 30 thus far that there is the hope that it can be reported out of committee by the end of this week, and the timing of the administration's proposal as it tracks with that is of some concern.

Secretary **Bell**. Yes.

Mr. **Packard**. I don't know whether the subcommittee will be able to address that concern.

One last question, Secretary Bell. If the responsibility for allocating the scholarship funds is turned over to the State to be passed on down to the local school boards, is there a system recommended in your proposal, or is this left entirely to the States to develop?

Secretary **Bell**. Our proposal is a block grant to the States, and they would have discretion. They would be required to prepare a report to us indicating how they have utilized the money to focus it upon the greatest need. We think that requirement would constrain them somewhat from not allocating the money based on where the critical shortages are. But it does rely on State education actions to do that.

Mr. **Packard**. I hope there would be consideration for the proposal at least to give incentives to matching by a private enterprise, private industry or by local agencies.

Secretary **Bell**. Maybe our language ought to emphasize the incentive aspect of it more.

We deliberately avoided requiring matching. We discussed that at considerable length and decided we ought not knowing what the pressures are on budgets there, also.

Mr. **Packard**. Thank you, Mr. Chairman.

Mr. **Kogovsek**. The Chairman recognizes the gentleman from Montana, himself a former educator, Mr. Williams.

Mr. **Williams**. Thank you, Mr. Chairman. It is nice to see you here again, Mr. Secretary. We, of course, appreciate your interest in this area, and we appreciate your leadership in this area.

There may be a coming crisis in American education and a crisis in American education very quickly turns into a crisis for all Americans. I note a difference between the amount that the administration is requesting to help alleviate or perhaps solve this crisis, and the amount requested in our bill. There is about a $200 million difference. There isn't anyone in America that doesn't recognize that money is indeed scarce.

I just came from a meeting in which we were reviewing the administration's fiscal year 1984 budget as we have it. It calls for total outlays of about $848 billion, that compared with $200 billion for a program begins, I think, to put this in the proper perspective.

The money is there, it just depends on where the Congress of the United States and the President of the United States wish to spend it. In this budget, the President of the United States has called for a 14-percent nominal growth in defense spending. By the way, that means that while the Nation had expected that defense would cost $1.5 trillion in the next 5 years, those expectations are wrong. It won't be $1.5 trillion in the next 5 years, it will be $1.8 trillion in the next 5 years.

So in the White House, the will is there to spend an increased amount of money in defense. In this committee—and I would hope in your Department, sir—it should be there to spend an increased amount of money in education, and particularly in those areas that have great need such as math and science.

I recognize that you are under a significant constraint given the nature of the freeze or squeeze that is being promoted from the White House, but I am hopeful that you will not oppose the efforts of this committee and hopefully of the Congress to adequately fund math and science awareness, math and science education in America.

Secretary **Bell**. We think you will be quite pleased with our 1984 education budget, Mr. Williams, and as you look at the $50 million that we are recommending for math and science I would urge, as soon as it is released from under its embargo in just a couple hours, that you see what is happening over in the National Science Foundation. The total of what we are doing, by "we," I mean the administration, needs to be reflected in both agencies.

We think, especially as you contrast it to last year's budget proposals, that you are going to be quite pleased with the recommendations we have made. We still have a tight budget, but you won't find the reductions that some of you are anticipating this year. In fact, you will find some increases in some areas.

Mr. **Williams**. Thank you.

Thank you, Mr. Chairman.

Mr. **Kogovsek**. The Chair recognizes Mr. Coleman.

Mr. **Coleman**. Thank you, Mr. Chairman.

Mr. Secretary, I do thank you for coming up and making this very good suggestion on trying to increase the population of teachers we have in math and science. I think this is something that we ought to incorporate in this type of legislation because then we are reaching the first problem, that is to expose more young people to math and science by people who are trained in it, and I think the bill can also relate to those people who are already teaching math and science to upgrade their ability. Finally we might want to increase specialization in certain areas. Those are the three criteria the committee has to look at.

I think your suggestion is a very good one. I thank you for making it.

Secretary **Bell**. Thank you.

I might just comment, Mr. Coleman, on a couple of comments from the committee about the fact that this is the first legislative initiative that I have had since I became Secretary 2 years ago. I would emphasize to you and to the committee that the President is deeply interested in the math, science, and high tech problem. He sent a message to a major national conference that we had on this problem, I wouldn't want the committee to have the impression that I had to argue hard to get the President to support this initiative.

He is favorable to it and it will be reflected not only in our budget but in the National Science Foundation budget.

Mr. COLEMAN. Asking just one budget question, is it correct that you are limited to a $50 million authorization for such a program?

Secretary BELL. I had an overall budget dollar that we negotiated out, an overall amount. Within the constraints of that amount—knowing what National Science Foundation was doing and anticipating through the coordination of Dr. Keyworth, who is the President's science adviser—I structured the limited and highly targeted program that focuses upon the teacher shortages.

Now, I did it, Mr. Coleman, as I looked at other budget areas, knowing I had to also keep a viable student aid program and provide aid to the disadvantaged and the handicapped.

I simply didn't want to sacrifice those programs more deeply for this program. We also felt the proposal that we had—if it would be responded to by State and local levels—would be expanded and the impact would be greater than the dollars that we are talking about.

That plus the NSF budget. We wouldn't say that it is totally adequate and fully overflows the cup, but we think it is a pretty good effort for what is, after all, primarily a State and local responsibility.

It is stimulation, we think, in that arena.

Mr. COLEMAN. I agree with you it is certainly not going to be too much.

Mr. KOGOVSEK. The gentleman from Illinois, Mr. Simon, is up next.

Mr. SIMON. Thank you, Mr. Chairman. I have no questions.

Mr. KOGOVSEK. The gentleman from Texas, Mr. Bartlett.

Mr. BARTLETT. Thank you, Mr. Chairman.

Mr. Secretary, I apologize for not being here for your complete testimony. I was helping to teach in elementary school where my daughter is enrolled this morning.

I have two questions. First I understand Mr. Petri had earlier inquired as to how to get an estimate or range as to how many teachers per year this program or the Department would estimate. I understand those numbers are obviously difficult to pinpoint. But at what point could we expect to have some sort of an estimate as to the total number of scholarships within a range that this program would expect to generate?

Secretary BELL. It is a $50 million appropriation. Our requirement we now have in the draft of our bill—incidentally we hope to have it up to you next week—limits administration to 4 percent and we were recommending $5,000 scholarships. So you can see from that about where we will be with numbers. That would be the maximum scholarship.

If the school board wanted to grant a smaller one and give more of them, and if they wanted to come up with matching and we hope they will, we are not requiring it but we hope the States will and the State legislatures will. Then we get a lot more response to this.

We found that in a number of programs where there has been a concern on the national level that States have developed their own programs. We found many instances. This is true with the compensatory education program. Most of the States now have a State equivalent to title I, so we hope that kind of response would be generated by the stimulus of this program We know the budget is tight and limited.

Mr. **Bartlett**. Do you know what percentage of each State's allocation would be permitted to go to administration and overhead?

Secretary **Bell**. We would only permit 4 percent to be for that purpose.

Mr. **Bartlett**. To follow up, in terms of having the biggest impact I would strongly urge as you consider the bill, that you consider including matching and not just matching from local budgets necessarily, but to permit States to recruit matching from private sources and private industry. We have heard testimony here, and you know it and your Department knows, that that is where the priority is being set out there, not set by Congress, the priority will be set by individual actions within the community.

Secretary **Bell**. Right.

Mr. **Bartlett**. I wonder if you could respond to this, would you anticipate, should this Congress suggest matching, would you anticipate opposing such a matching requirement?

Secretary **Bell**. We have weighed the matching provision quite carefully. In my conversations with State and local education agencies, I find a great deal of resentment on matching requirements and so after a lot of discussion inside the administration and outside, we decided not to require matching but to encourage it and to advocate it as strongly as we can knowing what the budget constraints and problems are at the local level. We finally decided we would not require matching but we will surely be advocating it wherever we can in urging as you indicated, urging the private sector as well as State and local entities, to help respond to the problem.

Mr. **Bartlett**. One final question, and that is that you suggested, Mr. Secretary, that your bill in final draft would be to Congress next week. I would join with you in urging that this committee and Congress exercise some restraint in considering this bill so that we have all the facts on the table as we prepare our own bill. I would think that here on January 31 that we could wait a week or two and still be in a hurry to set this as a national priority, but not necessarily in a hurry to see who can get to the floor first.

Let's make it a good bill where we consider all the facts. I know you will work with this committee in doing that.

Secretary **Bell**. Thank you for that, Mr. Bartlett. We hope the approach we have will be weighed by the committee, especially since we think it will give an immediate turnaround in increasing the supply of teachers. We think that this is a small weakness, but a significant one in H.R. 30 and also in S. 248.

We will put maximum pressure on getting our proposal up here to you.

Mr. **Kogovsek**. The committee thanks the Secretary for his time this morning.

Mr. Secretary, do you have any closing remarks?

Secretary **Bell**. No, I don't. I appreciate the opportunity to be here.

Mr. **Kogovsek**. Thank you for being here, Mr. Secretary. We will let you get back to your budget briefings.

The Chair would now call Mr. Raymond Barber, superintendent of public instruction, Kentucky Department of Education; and Ms. Alice McDonald, deputy superintendent of public instruction from the Kentucky Department of Education.

Thank you.

STATEMENT OF RAYMOND BARBER, SUPERINTENDENT OF PUBLIC INSTRUCTION, KENTUCKY DEPARTMENT OF EDUCATION

Mr. **Barber**. Thank you, Mr. Chairman. Ms. McDonald could not be here and she sends her regrets.

I appreciate the opportunity to appear before the committee and address the subject on the need for more and better math and science teachers. I have submitted a copy of my remarks to the committee and with your permission, I would like to talk on the subject rather than read those remarks into the record.

Mr. **Kogovsek**. Your prepared statement will be made a part of the record without objection. You may proceed as you wish.

Mr. **Barber**. There is an escalating awareness that we are faced with unprecedented problems in science and math education across the Nation.

When I was asked to appear before the committee, I did some research in the Department of Education of Kentucky over a 10-year timeframe and in 1971 we certified 194 science teachers; in 1981 we certified 66 science teachers. So that alone, I think, will prove that we in Kentucky have a crisis in math and science teachers.

Mr. **Kogovsek**. Give me those figures again?

Mr. **Barber**. In 1971 we certified 198 and in 1981 we certified 66 math and science teachers.

The dilemma that we really face in Kentucky in math and science is that 20 percent of the youngsters taking math and science in high school and in our junior highs and middle schools, they are being taught by teachers not qualified to teach math and science. The reason for that is that under the certification standards if you are an elementary major you can teach grades 1 through 8. In recent years, we have gone to the concept of middle schools and junior highs and we have people with elementary majors teaching math and science in those areas.

As a result we are not getting a good math and science student admitted to the 9th or 10th grade.

We in Kentucky recognize this problem and initiated legislation in the last session of the Kentucky General Assembly for math and science teacher loans. Under those provisions we would loan a candidate that wanted to sign an agreement with the State department of education that they would teach math and/or science with a major in those fields and we would loan them $2,500 per year to go to college and become math or science majors.

I would say to you that we had over 2-to-1 application of those that we could accommodate, almost a 3-to-1 ratio.

They sign an agreement with us that they will teach in Kentucky for a minimum of 3 years, the maximum length of the loan is 3 years starting at the sophomore level in college, and that they will teach math or science in Kentucky for a period of not less than 3 years; and that if they teach a major proportion of the schoolday; and they are forgiven 1 year of the loan for each year that they teach.

If they do not teach, then they must repay the funds to the department of education with the current Treasury note rate of interest plus 3 percent.

We can track that because we certify the people in the State of Kentucky so we really have no problem subtracting the loan and the student that received it. I want to reenforce what Secretary Bell mentioned, we need to target the current teacher and the teacher to be. We in Kentucky are encouraging those that are teaching in the middle schools and the junior highs to take advantage of the loans that we have available and take a leave of absence, sabbatical leave, and go back and become math or science majors.

We do not accept the fact that you become eligible for teaching in a field, we require either a major in science or math or both.

So we have addressed the program in Kentucky with some assistance from the Federal level and we feel that we can overcome the problems that we have in the State of Kentucky relative to math and science teachers.

I am pleased to hear of the $50 million appropriation for scholarships. We debated whether to go to scholarships with the loans, and our decision was that we felt we could obligate the person under the loan system easier than we could under the scholarship system.

We have adequate numbers of math and science majors being produced by the State colleges, but they are not becoming teachers.

Also on the 3-year loans, this will encourage high school students to take more math and science in their curriculum at the high school level. On February 8, I will recommend to our State board of education that we up the requirements in math and science for graduation. The requirements have been raised for entrance into State colleges without condition. So we feel that it is necessary for us to move in the same direction to accommodate the students going to college in Kentucky.

Some suggestions I would like to make on H.R. 30, I wonder how many takers we will receive for a 1-year scholarship or loan and obligate ourselves for 5 years? This concerns me a little bit because I doubt if I were a student and I had a 3-year college term that I would obligate myself for 5 years for 1 year of books and tuition.

I would also suggest that we target more upon the classroom teacher than on inservice and software and hardware at the present time. These are good on a long-range basis, but on a short-term basis to solve our problem I concur with the Secretary that we target on the present classroom teacher and those teachers to be.

So I would be glad to answer any questions relative to our program in Kentucky, which we have and which is working very well. We will be able to double the number of recipients of the loans next year, and we have $225,000 for the first year of the biennium and better than $450,000 for the second year of the biennium.

[Prepared statement of Raymond Barber follows:]

PREPARED STATEMENT OF RAYMOND BARBER, SUPERINTENDENT OF PUBLIC INSTRUCTION, DEPARTMENT OF EDUCATION, COMMONWEALTH OF KENTUCKY

EMERGENCY MATHEMATICS AND SCIENCE ACT

Part A.—If Chapter I decreases, this dies:
(1) 5 percent to State Department of Education;
(2) ¾ of remainder on 5-17 population;
(3) ¼ on formula by Secretary of Education; and
(4) Requires a "state plan" for use of state money
Part B.—Congressional scholarship:
(1) 300 first year and 600 second year;
(2) For 2 years and above average grades;
(3) Completed 3 years;
(4) Formally expressed intention to teach;
(5) Must teach 5 years;
(6) CSSO may designate other fields;
(7) 10 percent to IHEs for science and math improvement;
(8) 25 percent of fund in science for junior colleges;
(9) 1984 or 1985 summer institutes;
(10) NIE to do research—not more than 10 million; and
(11) Challenge grants (⅓ cost) for science equipment not to exceed 50 million.
Part C.—Total not to exceed 300 million in 1984:
(1) Part A not more than 250 million; and
(2) Part B not more than 50 million

Across the United States, there is an escalating awareness that our educational systems are facing unprecedented problems in science and mathematics education. Most of these problems are at the secondary and middle/junior high school levels where there is a critical shortage of qualified science and mathematics teachers. The scarcity of expendable supplies and equipment, coupled with the deterioration of the science laboratories has reduced the quality of science and mathematics education to a point that our national security may be threatened.

The shortages of science and mathematics teachers has been documented by the National Science Teachers Association, the American Association for the Advancement of Science and most recently by the national convocation sponsored by the National Academy of Sciences and the National Academy of Engineering. The Kentucky Department of Education has documented the production of science and mathematics teachers for the past ten years. In 1971, Kentucky produced one hundred ninety four (194) certified science teachers and sixty six (66) in 1981. In our state, the shortages are critical in physics, earth science, chemistry and mathematics.

Many articles and published accounts of this dilemma emphasize the decline in the production of science and mathematics teachers. Of major concern to public school officials is the number of science and mathematics classes that are taught by "out of field" personnel. In Kentucky, over twenty per cent of the science classes are taught by teachers who do not have proper certification in the sciences. A recent survey by the National Science Teachers Association indicates that among newly-employed science and math teachers, 50.2 percent were unqualified to teach science or math.

As Superintendent of Public Instruction, I sponsored legislation and a biennial budget to help correct deficiencies in the production of science and mathematics teachers. The passage of Senate Bill 392 by the 1982 Kentucky General Assembly has gained the attention of national leaders in the American Association for the Advancement of Science (AAAS), the National Science Teachers Association (NSTA), and the United States Department of Education.

Senate Bill 392 is a loan program designed to attract and retain qualified teachers in the math and science fields in grades 7-12. A college student applying in the sophomore year will be eligible to receive a loan for a maximum of three years for an annual amount of $2,500. If the student upon certification then teaches science or mathematics for a major portion of the school day for three years, he/she will not have to repay any part of the loan. For each annual loan received, one year of teaching service must be rendered in the public schools of the Commonwealth. In the event the loan recipient does not teach, the full amount of the loan will be repaid at an interest rate of treasury bills plus three percent.

The Department of Education has developed regulations and guidelines for administering the program. Students have been asked to apply through the twenty-three colleges and universities approved by the State Board of Education to prepare teachers. The recommendations of the institutions are forwarded to the Department of Education for final selection. Currently, there are approximately two or three applicants for each available loan.

The 1982-83 budget contains $200,000 for this program, and we are supporting ninety-nine students this academic school year. In 1983-84, there is $410,000 which will continue the current loan recipients and add an additional one hundred new students.

Because of Kentucky's work in this area, several state agencies, scientific societies and publishing firms have requested copies of our incentive loan program which is serving as a model for action.

The House Committee on Education and Labor, Subcommittee on Elementary, Secondary, and Vocational Education is to be commended for sponsoring House Resolution 30, a bill designed to improve elementary, secondary, and postsecondary education in mathematics and science. Based upon my review of House Resolution 30, I offer to the committee the following comments and concerns:

(1) The flow through funds to local school districts have the potential of significantly improving mathematics and science instruction of they are in sufficient amounts. The Bill would be improved if there were a minimum amount per child, otherwise the state would be required to make cooperative arrangements among local school districts to achieve the objectives of Section 604.

(2) The "congressional scholarships" should be awarded to students who will attend an institution of higher education in his/her own state. We will have a much greater chance of attracting students to teach in rural and isolated areas if they attend institutions closer to home.

(3) It is unrealistic to ask a person to teach five years in order to satisfy a one-year loan. I don't think you will have many students who will commit themselves to five years of service. In order to attract students into the science/mathematics teaching fields, offer the loan to entering freshmen with the stipulation that for each annual loan received, one year of teaching service must be rendered.

(4) The provisions of Section 625, the "challenge grants," provide for only one-third of the cost of scientific equipment. This will create a situation in which poorer districts who most likely have the greatest need will probably not be able to participate in this part of the program. I suggest that this section be rewritten and that equipment grants be provided on a need basis.

House Resolution 30 provides the basis for a broad national effort that will provide the framework for a scientific and technological awareness that is vital to the survival of the country.

Mr. KOGOVSEK. Thank you, Mr. Barber. The chairman gives his apologies for his absence due to being called to the White House this morning. He wanted to be here and he will return shortly.

He has asked that you expand on your comments regarding matching. Would the school districts and businesses in Kentucky be able to meet any matching requirements that we enact as part of this legislation?

Mr. BARBER. I have some concern about the one-third matching Federal, two-thirds local school district.

My concern there would be relative to the fact that the rich districts could fully participate in this type of a program where the poorer districts, where the need is probably greater, of course, could not fully participate.

So I have a problem with this part of the legislation, and it is addressed in the written remarks that I submitted to the committee.

Mr. **Kogovsek**. The program you described to us which you have, and that was a $2,500 per year loan?

Mr. **Barber**. Yes.

Mr. **Kogovsek**. How old is this program?

Mr. **Barber**. This is the first year, the semester of 1982 is the first time. We are the only State of the 50 that has a program of this type.

Mr. **Kogovsek**. You indicated in the initial remarks you made to the committee that you see the importance of science and math education starting from the elementary level and working up toward high school and college. In other words, if we don't have a strong early base you won't have a good science or math instructor later on.

I would concur with that.

In lieu of that remark, would you concede or disagree with the Secretary's proposal as far as the administration, trying to get teachers who have either retired or are not active in a certain field and putting them back in the school for 1 year hoping they will come out as good science and math teachers?

Mr. **Barber**. I would say that you would need to give the scholarship or the loan—whichever it might be—to the teacher that is currently teaching upon recommendation of the local board of education or the superintendent at the local level.

I cannot perceive a superintendent or board of education recommending that a practicing teacher that is not competent receive a scholarship or loan to become a math-science major.

I do think you will have problems of a person going back in the summer and becoming qualified to teach math or science. That is the reason we stipulated in our legislation that you must become a math or science major in order to qualify for the loan.

Mr. **Kogovsek**. You have thrown out some figures that in 1971, 194 math and science teachers were certified. Is that the State of Kentucky?

Mr. **Barber**. Yes.

Mr. **Kogovsek**. And in 1982, only 66. So you went down from 194 to 66?

Mr. **Barber**. Yes.

Mr. **Kogovsek**. In your opinion, what is the main reason for that sharp decline in the 10-year period?

Mr. **Barber**. First of all, the salary. In private industry, they could make many more dollars per year than they could teaching. I concur with the Secretary that we are going to have to make a differentiation between the salaries of math and science teachers and some of the other critical areas, from the areas where we have an abundance of teachers.

It would not be in agreement maybe with KEA, but I feel that it is going to be necessary if we are going to train and recruit and retain math and science teachers.

Mr. **Kogovsek**. Thank you, Mr. Barber.

The gentleman from Montana?

Mr. **Williams**. Thank you, Mr. Chairman.

Mr. Barber, in your opinion, to what degree do the people of America—you may want to confine yourself to the citizens of Kentucky—have an appreciation of the crisis in math and science?

Mr. **Barber.** I think the change in technology and the awareness of test scores that we see are making us more aware that we need better science and math teachers because the date shows us we are not turning out as good a student in those fields as we used to.

Mr. **Williams.** The professionals understand that and this committee is aware of it. I wonder if the people paying the bills understand it? Do they know that we have a shortage to crisis proportions of math and science and engineering professors?

Mr. **Barber.** Yes, our Commonwealth is, because we did not have a dissenting vote against the bill that we submitted to the General Assembly requesting additional funds for math and science loans to students who have become math and science majors.

So in Kentucky the people are very much aware of the fact that we do have a need, we do have a crisis, and I doubt if Kentucky is too uncommon to other States in that respect.

Mr. **Williams.** That is encouraging because support for education among the populous has always been fairly widespread in this Nation and it is on that foundation that we have been able to secure and support the grand education system we have.

Thank you, Mr. Chairman.

Mr. **Kogovsek.** Mr. Barber, thank you for being here this morning. We appreciate your testimony.

As I indicated, your statement will be made a part of the record and thank you for being with us.

Mr. **Barber.** Thank you, sir.

Mr. **Kogovsek.** At this time, the Chair would recognize the gentleman from California, Mr. Dymally, who was to have testified earlier, but couldn't be with us until now.

We appreciate the fact that you are here, Congressman.

STATEMENT OF HON. MERVYN M. DYMALLY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. **Dymally.** Thank you, Mr. Chairman.

I have a prepared statement.

I want to thank the members of the subcommittee for inviting me to comment on H.R. 30 and the problems it is meant to resolve.

Let me begin by saying I share Congressman Walgren's hope that the 98th Congress will be the one to get the United States back on the track toward excellent science and mathematics education.

In 1981 when the Congressional Black Caucus dedicated a portion of its annual legislative weekend to raising public awareness about the decline in quality of science and mathematics education, relatively few people knew the magnitude of the problem.

I am pleased that awareness has grown steadily since that time. I sense that the Congress and the country are now ready to act.

As others have commented here, we must ask ourselves "what is the proper course of action?" Looking at the various solutions raised in the 97th Congress, and now, in the 98th Congress, it seems they can be divided into two camps. There are solutions aimed at a permanent resolution to the problem; these solutions generally take the form of some ongoing body whose role is to see that our educational offerings adjust as the Nation's needs change. There is a vestige of this type of solution in H.R. 30. It is to be found in the directive that the Secretary of Education shall make an inventory of present needs in science and mathematics education. I call it a vestige because no provision is made for ongoing monitoring of changing needs.

The second type of solution is aimed at taking care of what we know to be immediate problems. We know, for example, that many present day science and mathematics teachers are teaching out of their field. They have no formal training in the areas they teach. And many of those who have formal training received it so long ago that it is now outdated.

Senator Dodd and I introduced a bill last session, and will reintroduce it this session, aimed at resolving this particular problem.

There is nothing wrong with either approach. There is no doubt that we must move quickly to solve the problems that face us right now. At the same time, I think the 98th Congress will fail ultimately in its effort to resolve the problem if it turns out that Members of the 108th Congress find themselves sitting in this room saying that what the 98th Congress did was fine for a little while, but that it had no lasting effect.

I am aware that there are many skeptics who scoff at the notion that planning for the future is possible, let alone an activity we should pursue seriously. They say too many things change to make the activity worthwhile. It is fortunate for the United States that those who wrote our Constitution were advocates rather than skeptics of planning. The stability and relative prosperity of the country owe much to their foresight. Their example is a positive one for us here.

A negative example comes from the past benign neglect of long-range programs. Consequences of this neglect have been well-illustrated by witnesses in the present hearings. With such a definite problem area, I believe flexible planning is possible and the lack of it, fatal.

I would like to pursue the theme of two approaches, two examples, two factions, a bit further.

Historically, the National Science Foundation has been charged with fostering excellence in science and mathematics education.

Its charter states that "The Foundation is * * * directed to initiate and support * * * programs to strengthen * * * science education programs at all levels in mathematical, physical, medical, biological, engineering, social and other sciences." At the same time, the Department of Education is charged with promoting excellence in education generally. Both agencies, then, have responsibility for the state of science and mathematics education in the country.

But in oversimplified terms, the National Science Foundation has concerned itself with the training of scientists and the Department of Education has concerned itself with the basic education of all children. The NSF has shown its allegiance to science and scientists while the Department of Education has allied itself with teachers and teaching.

To show the effects of this division and this isolation of one agency from another, I will point out an example. When the National Science Foundation was given the task of spearheading our effort to achieve scientific excellence following the launching of Sputnik, the teaching materials that came out of that effort were geared toward students who might eventually become scientists. They were excellent materials in that respect. But they did not do enough to promote general scientific literacy. They helped the few, more than the many.

And that attention to the needs of scientists rather than to the needs of consumers of scientific products is part of the reason we sit here today trying to resolve the problem of general scientific illiteracy. On the other hand, the chart which I would submit for the record here illustrates in a startling way that the deline of science education in this country is strongly correlated with the decline in funding devoted by NSF to science education.

I am indebted, by the way, to Sarah Cline of the National Science Teachers Association for this chart.

Within the Congress, committee jurisdiction over science and mathematics education has shown a parallel division and isolation, with the Science and Technology Committee having jurisdiction over the NSF and the Education and Labor Committee having jurisdiction over the Department of Education.

The division both at the agency and the committee levels has, I believe, fostered a kind of partial blindness to the scope of the problem we now face. At this time we need to see not only that those who will become scientists are well trained, but also that those who will be the recipients of science might use its fruits knowledgeably and responsibly.

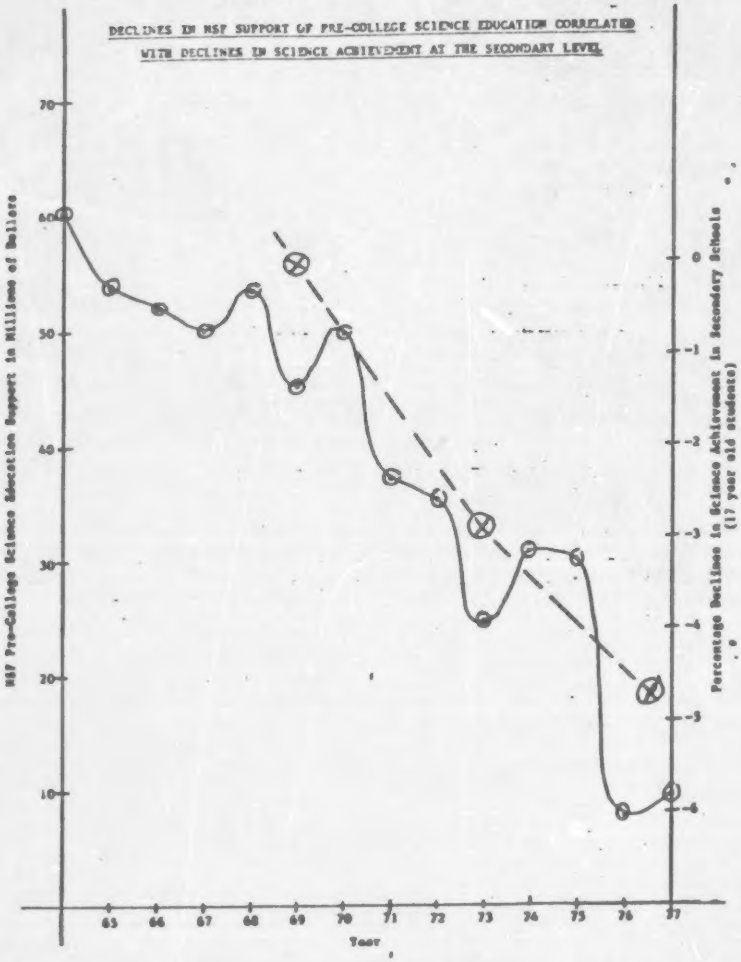
Because, in fact, science and society are interdependent we should not be fighting for the supremacy of one agency over another, one committee over another; we should not be fighting for short-term solutions only or for long-term solutions only. I believe this can be a battle without losers if we have the foresight to fight the right war.

We can choose to battle each other over the question of who should solve America's science education problem. This is the battle of politicians, a battle of winners and losers. It is the kind of battle with which we are most familiar. But there are occasions when the seriousness of a situation demands that politicians battle with the wisdom of statesmen. The statesman's role is to bring all forces to bear on a common problem. If we choose the battle we know best, the result will be defeat for the children of our country, for we will not have solved their problem. I agree with Congressmen Brown's and Walgren's proposals that an adequate solution demands a comprehensive approach. Rather than seeing the resources of one agency or committee or the thrust of a single idea as opponents, we should see each as a necessary tool toward overcoming a common foe.

I am confident that when H.R. 30 is signed into law, it will reflect the wisdom of statesmen rather than the spoils of internal war.

Thank you, Mr. Chairman.

[The chart to Mervyn M. Dymally's statement follows:]



DECLINES IN NSF SUPPORT OF PRE-COLLEGE SCIENCE EDUCATION CORRELATED WITH DECLINES IN SCIENCE ACHIEVEMENT AT THE SECONDARY LEVEL

Mr. Kogovsek. I thank the gentleman from California for his testimony. I would indicate that his chart will be made a part of the record without objection.

I think that the point that the gentleman makes is a good one. We do have, not a conflicting, but we could have a problem insofar as jurisdiction is concerned concerning this piece of legislation. I think that certainly the Committee on Education and Labor has direct cause for concern and has cause for oversight in a piece of legislation like this. There is no doubt in your mind and in mine that NSF also has a role here and I would hope that through the testimony that we hear not only today, but in days to come, that we can impress upon this committee and other people who are interested in this very, very important area, that as the gentleman from Montana indicated and others have indicated, that right now we have a lack of appreciation for how critical the problem is insofar as math and science is concerned, with the lack of teachers, the lack of direction.

I appreciate your testimony and I would ask if the gentleman from Montana has any comments or questions?

Mr. Williams. I have no questions. I would like to thank you for your kind remarks and the gentleman for his leadership and for his work in this area. We appreciate your being here this morning.

Mr. Dymally. Thank you. I think it is good that both Science and Technology and the Education Committee are looking at this issue, because we have the NSF looking at mostly scientists and scientific needs, the Department of Education looking at the other side.

I think by blending these two, we can get the country back on the road to having good mathematics and science teachers and good mathematics and science education.

Mr. Kogovsek. Thank you very much for your testimony.

The Chair would now call the second panel to the table and I will announce them. Ms. Eugenia Kemble, assistant to the president of the American Federation of Teachers; Mr. Richard Johnston, superintendent, Alamosa Public Schools, Colo.; Mr. Robert C. Bowen, vice president, Marketing, McGraw-Hill; Mrs. Helen Washburn, president, American Personnel and Guidance Association; Ms. Dorothy W. Blake, President, American Association of School Librarians and coordinator of planning for Media Resources and Utilization, Atlanta Public Schools; and Dr. James G. Greeno, University Professor of Psychology, Learning Research and Development Center; University of Pittsburgh.

Thank you for being here. You don't necessarily have to testify in the order you are called, please proceed as you wish.

STATEMENT OF EUGENIA KEMBLE, ASSISTANT TO THE PRESIDENT, AMERICAN FEDERATION OF TEACHERS

Ms. Kemble. I am Eugenia Kemble, special assistant to the president of the American Federation of Teachers, AFL-CIO. We represent 580,000 employees, mostly elementary and secondary school teachers, but also civil service employees, university professors, and paraprofessionals. We are pleased that you have decided to take this issue up and I think we are doubly pleased to see that this administration also thinks it is important.

I hope someone will ask me at some point what our reactions are to the proposals from the Secretary this morning.

I would like to start by first laying out for you how we see this issue a bit and then go into the specifications of the bill. We will have two additional documents for you in addition to the testimony that I am presenting and I would hope they would be part of the record. One is a longer analysis of the problem than the one I will give, and the other is a spot survey we did of key FTA areas, recruitment patterns, shortages, people teaching on the job out of certification areas, and we found those facts are not generally available.

Mr. **Kogovsek**. Without objection, they will be made a part of the record.

Ms. **Kemble**. First of all, it is important to say something general. We are facing this problem in the midst of an economic depression or something close to it and I think it comes to us in the context of a whole lot of concern about the Nation's infrastructure, our defense, the degree to which technological industries are growing relative to others, our position as a world power, how our education system compares with those of our international competitors. I think it is important, because it makes it clear to us this is a matter for national concern, it is a Federal problem, not only an education problem, but a defense matter, an economic matter and for that reason, we think major input of funds is warranted.

I think most of you are aware of the scope of the problem. You have heard it from other witnesses. If I could, it implies four points, it is clear that test scores are down in these areas; curriculum requirements are minimal at the State or local level and do not compare with those of our international competitors; students are losing interest in the subjects we are addressing here, and they fall away from them early if students do not require they stick with them; and, of course, we are faced with a severe teacher shortage in virtually all but a handful of the states.

I think it is important to raise the economic education connection. Because of the problems the way the issue is defined, we think that this math-science crisis is a matter for all students, a matter of general concern and the way it is addressed will affect education broadly. I can't emphasize that too strongly. If we look at the labor market and what business is telling us, what we see is its general skills required, they want more math and science for all students, not just precollege students.

If I might just point to what I think the false assumptions are, and I think we have seen evidence of them here this morning, and I would like to do that.

First of all, one is that since high technology is growing so rapidly and indeed that is a debatable point itself, the main concern of business with math and science stems from its interest in having a select group of students prepare for advanced education and training.

Two, since math and science become defined as specific subjects at the high school level, this is where to focus all the attention. We disagree strongly with this.

Three, because math and science are regarded as preparation for more advanced education, their decline is a precollege problem rather than one for general education at all levels. There are plenty of arguments and good evidence that all of these assumptions are wrong. They have led to initial responses that concentrate on colleges preparatory students, ignore the importance of the grades and wrongly interpret business wisdom on the subjects.

I might point out from the reports we have seen, these are the same mistakes that were made with regard to the National Defense Education Act.

One other point, as we look at the demographic patterns, it is clear that there is going to be a reduction in the numbers of 18- to 25-year-olds. At the same time, as that goes down, the proportion of these students that will be non-English speaking and disadvantaged will go up. In our view, that reinforces the argument that math and science should be a matter of general education concern because these students are going to have to compete well in the labor market.

Let me turn to some of the education issues as we see them. As I have indicated, we are disturbed that the focus is on precollege and that we have no national commission looking to understand why math and science are important to general education and why they must be developed in the early grades.

We think the focus educationally ought to be on two major things; first of all, school districts should be encouraged and assisted in efforts to upgrade and add offerings in math and science. While curriculum matters are not a matter for the Federal level, we think that assistance in this area is important.

Second, that there be a much stronger focus on the elementary school level. All the research points to the importance of the early years in terms of intellectual development. If you are looking at trying to teach students the scientific method which is a basic learning technique, or the logic of math from things we have looked at, these are really put down in the minds of most children at a very early level and it would be a mistake to ignore this.

In terms of teaching forces, what we see are first of all that a major problem here is inadequate teacher salaries. We don't expect you to be able to address that problem, but I must say that here for the record that is a major problem.

In terms of things you can look at, people are teaching already out of their certification area. Those at the elementary level are not getting such efficient upgrading training, specialist support, and so on.

We would argue for that the Federal level and in general, large-scale efforts at retraining on the job teachers, both those already certified or licensed and those seeking new qualifications in science and math. We would urge special measures for elementary school teachers for all the reasons I have indicated.

We would also urge that you look at the recruitment end. While Secretary Bell is very concerned with solving the problem in the short term, I think it is important for the Federal Government to consider scholarships and loan programs that would be addressed at bringing new people into the field.

Now, let me just go briefly from these priorities to a look at your bill. First of all, we don't think there is enough money in it. While we can't give you comprehensive statistics on precisely how much teachers are teaching out of their area and how this relates to the numbers of teachers who are aging and likely to leave and how this in turn relates to the numbers that are not being recruited or the numbers actually going through preparatory programs and not ending up in teaching—while we can't give you all those details, we feel from everyone we have talked to through our organization and through others that the problem is quite massive and that the amount of funds that you have given to it are not sufficient.

Two, where the money goes; we don't have a specific formula to suggest to you and one of the reasons for that is because this formula issue is a problematic one. The kinds of information that I just indicated are not readily available. We do think the one you have in place is fraud. As we understand it, it would put money into low-income States.

From our experience, you have wide variation within States, even high-income States, as to where the money is needed. If you accepted my argument that all students, especially given the proportional below income and disadvantaged, should be addressed in terms of this problem, then I think you would see that we would be very concerned that large pockets of education systems that have large numbers of these students would not get sufficient funds.

Whatever you decide on the formula, we think that in this period and indeed in general, it would make a lot of sense to attach some fairly strict acting and reporting requirements. If, ultimately, it decided the funds should go to the States and the States in turn should be responsible for seeing to it that those funds go to the right places, then they ought to have to report back on that. We are in a period when money for social programs is being attached and under strong scrutiny and we think it would not hurt to make fairly strong demands in terms of evidence that the money is well spent.

I might say, also, if it came down to a choice of low-income districts and high-income districts, we would certainly come down on the side of the low-income districts and I might point out to you that in the studies done on NDEA, this was one of the flaws of that particular program.

Other suggestions in relation to your bill, the competitive scholarship program we think is a bit too symbolic, not sufficient money, perhaps the wrong people making decisions about who should get scholarships. We think scholarships are a good way to do things. I will not go into my criticisms of the Bell proposal, but I hope someone will ask me.

Summer institutes; they are a good idea and we are glad you addressed that. That was one of the successful aspects of NDEA. We think it won't hurt to pick up on that and go with it in more extensive form.

In terms of the research, again we see the bias for secondary coming through. We don't see why there shouldn't be a lot more done on the relevance of these subjects at the early grade levels. We think the evidence is there, but it ought to be systematized and put together so it could be used from committees like this and to help us with Federal legislation.

So I guess to summarize, I would like to say that we are very pleased that the committee is making this effort. We don't think the amount of money is sufficient. We don't think you solved the direct problems. We would hope you would focus on the teacher retraining item. We would agree with the Secretary that in terms of doing something quickly and doing something that would really get to the heart of the problem, that it would be important.

We also hope that you will agree this is not just a precollege problem and that one of the things this committee can do is to inject into this debate a very real emphasis on math and science for all students and math and science at the early grades.

Thank you very much.

[Prepared statement of Eugenia Kemble follows:]

PREPARED STATEMENT OF EUGENIA KEMBLE, SPECIAL ASSISTANT TO THE PRESIDENT, AMERICAN FEDERATION OF TEACHERS, AFL–CIO

I am Eugenia Kemble, special assistant to the president of the American Federation of Teachers, AFL–CIO. The AFT represents more than 580,000 elementary and secondary teachers, school paraprofessionals, health care professionals, civil service employees and university professors. We are deeply concerned with this problem and grateful that this committee recognizes that it requires federal attention. We are appreciative that you have given the American Federation of Teachers the opportunity to express its point of view.

Before addressing the specific proposal you have before you, I think it would be helpful if you first had a sense of how we view this issue. Then I will turn to the specifics of the bill. This presentation will be necessarily brief, but it is based on two more extensive documents which will be available to you shortly. One is a spot survey of what is going on in key AFT States and local districts. The other is a more extensive analysis of what needs to be done than the one I am presenting here today. I hope you will be able to include them in your deliberations and reports.

First of all, we believe that to tackle the problem of quality in math and science is to tackle the problem of education generally. To deal with the math and science teacher shortage is to deal with the problem of teacher recruitment and quality generally. The questions we ask at every level of government and the answers we offer will ultimately shake the entire system. They had better be good.

We must start by recognizing that with the economy in the midst of a near depression, public education is pressed with the need to defend itself in economic terms. We are currently preoccupied with dire predictions of an erosion of the nation's infrastructure and of the decline of our technological competence, not to mention our faltering position as a world economic power. While public education should never gear itself solely to such concerns, to ignore them would be a disastrous mistake.

Within this context, and given these cautions, the crisis in math and science education is beginning to get the attention it deserves. Student test scores are down in these subjects. Curriculum requirements are often minimal and do not compare well with those of this Nation's economic competitors. Students lose interest in these subjects early and fall away from them as soon as school course requirements permit. To compound the situation, severe teacher shortages are emerging in both subjects in all but a handful of our States, largely because of the failure of teachers salaries and job satisfactions to compete with those in the private sector.

Some have taken the popularity of the economy-education connection as an indication that fitting education specifically to future job skill requirements is the best way to keep the educational enterprise and the demands of the economy running in tandem. But even if this were the sole purpose of education, which it is not, from the reports we have examined and the experts we have talked to, we have come to the conclusion that deciding on which specific job skills would be impossible. Experience has already shown that it is hopeless to try to predict labor market skill demands with any exactness.

Why is this important given the math/science crises? Because educators are already addressing the problem based on such false-assumptions as:

Since high technology is growing (to what degree and at what pace are also debatable), the main concern of business with math and science stems from its interest in having a select group of students prepare for advanced education and training;

Since math and science become defined as specific subjects at the high school level, this is where to focus all the attention;

Because math and science are regarded as preparation for more advanced education, their decline is a "precollege" problem rather than one for general education at all levels, including the elementary grades.

There are plenty of arguments and good evidence that all of these assumptions are wrong. They have led to initial responses that concentrate on college preparatory students, ignore the importance of the early grades, and wrongly interpret business wisdom on the subject.

There is one other dimension to the economic-education relationship worth mentioning here: Demographic patterns add additional considerations to any evaluation of the importance of math and science education. The U.S. Census predicts that within the next 12 years there will be more than a 25 percent reduction in the number of 18- to 25-year-olds. At the same time, the proportion of this age group likely to be from non-English-speaking and disadvantaged backgrounds will rise dramatically. The likely outcome of all of this is that competition among business for the better performing students will increase at every employment skill level. The more these less advantaged students are grounded in math and science, as well as everything else, the better off they will be.

I am not going to go into an extensive description of the math/science problem here. I am sure you have gotten that from other witnesses. It will be presented in our more extensive documents. But, I will try to indicate briefly why we put our emphasis where we do. I must also say that we have chosen to concentrate primarily on part A of the bill, because we think the main thrust of a solution belongs at the elementary and secondary level.

THE EDUCATION ISSUES

For many of the economic reasons indicated above, as well as because of the need for us to have a broadly informed citizenry able to deal with complex questions, we argue that all students should get more math and science. Right now we have no national commission to look at why science and math are important to the general education; why science and math literacy must be developed in the early grades; why all students, whether they expect to be employed or not, should develop what John Dewey called "scientific habits of mind."

Right now, this issue is too often being propelled politically by specialty groups who are understandably more concerned with math and science education for future scientists and mathematicians. And at the Federal level, at least, this is highly convenient for an administration that would prefer to nickle and dime discretionary funds into a few select, visible programs than really address the problem comprehensively.

We argue for two things:

That school districts be encouraged and assisted in efforts to upgrade and add offerings in math and science. Many will be pressing them to tighten standards for high school graduation for all students. While this process is not a federal matter, we think it important that districts get help.

The elementary school level is extremely important and is now being virtually left out of the national discussion on this problem. The future math and science competency of the nation may depend on whether we put proper attention here, whether it be resource updating, access to computers, time spent on the subject matter, etc.

THE TEACHING FORCE

A teaching force to match these priorities will not be easy to come by. Our AFT survey points to two broad problem areas, as do most of the other data now available. First of all, people are not coming into teaching in these fields in adequate numbers. The figures are well known. We think the major reason is inadequate teaching salaries to attract talented people, though we recognize the billions required to make teachers' salaries competitive are not likely to come for the Federal Treasury. Second, even with those we have on the job, there are large numbers who are teaching out of their license or certification area with emergency credentials, or sometimes just off the record altogether. Finally, we note once more the lack of attention being focused on the importance of the elementary school teacher, even as these teachers acknowledge their insecurities in these fields and the unavailability of opportunities to improve themselves.

We argue for:

Large-scale efforts at retraining on-the-job teachers, both those already certified or licensed and those seeking new qualifications in science and math. These should also be available to those facing layoffs. Such efforts should involve special institutes, including summer institutes, and the use of other forms of inservice support.

Special measures aimed at elementary school teachers which might include much of the above but would be specifically geared to their needs. At the elementary level there is need to upgrade all teachers in math and science skills, as well as to consider the supplementary use of subject matter specialists. No single solution will solve the problem.

Provisions aimed at longer term recruitment, including scholarships and loans, possibly with forgiveness provisions that would allow loans to be canceled for years spent in teaching. We would also like to see more outreach and counseling for high school students to urge some of the more qualified to enter teaching.

Our program priorities, then, are concentrated on: (1) upgrading curriculum for all students at all levels; (2) placing new emphasis on the importance of the early grades in teaching math and science; (3) retraining on-the-job teachers, again, with special emphasis on the early grades; and (4) recruiting new teachers with special scholarship and loan programs. While no long term solution for math and science teachers, and indeed, for all teachers, can fail to come to grips with the need for higher teacher salaries, we see the measures we have pointed to as the most productive focus for the use of federal funds. Let me turn now to the legislation before you.

THE EMERGENCY MATHEMATICS AND SCIENCE EDUCATION ACT

The most serious problem with this piece of legislation is the money it offers. When we get reports from virtually every state and district we contact that teachers are teaching math and science out of certification area or with minimal qualifications, and when we know there will shortly be a push to add curriculum requirements, we can only say that this amount of money cannot possibly have an impact. It would take three or four times as much to make a dent.

The next problem is where the money goes. This is the original NDEA distribution formula, unchanged. As we understand it, this tends to put money into low-income States, thus discriminating against States which though they may have higher per capita income in general, may have large pockets of low income within them. Besides, one might logically ask the question, if income is to be a distribution mechanism why not go directly to local districts?

I want to say very bluntly that we do not have a specific formula on distribution to recommend to this committee at this point. We know we don't like the one you have because it discriminates against States, and therefore localities within them, that we know are in need. I can say this much. Whether the formula that is ultimately used is this one or a per pupil formula or something comparable to the title I or chapter I formula, it ought to be backed up with a rationale that defends where the money is spent. It is necessary for the federal government to be able to account for that expenditure and explain what the money did to solve the problem. Simply put, the formula ought to make sense in terms of the problem to be addressed and the expenditure of funds ought to be accompanied by reports from states and localities on how it helped.

Some of this may sound as if I am belaboring the obvious. But talking about formulas makes everyone uncomfortable these days when it comes to Federal education legislation. After all, dollars are short. There are arguments that you have to spread them thin enough to get sufficient political support. Then there are arguments that they ought to be targeted to show impact. On this bill and on this topic, we are really caught in a bind. We know that the problem is widespread. It exists in both high- and low-income States and in both high- and low-income districts. Even if this bill provided the more than three times as much that we think it should, the question of impact would remain.

Of course, in any choice between high- and low-income districts, we would have to come down on the side of where the Federal Government has traditionally helped, in low income districts. And, while we do not have the ideal formula to throw out here, given the dollar amounts this committee is considering, we find ourselves wondering how the distribution pattern, together with the small amount of funds, provide anything that can really make much of a difference.

Ideally we would like you to come up with a method for putting the money on the most important problem, qualified teachers, and that means retraining. We also hope that districts and states will upgrade math and science curriculum standards. So, the place to put the money is where you have people teaching out of certification area or with minimal standards who need retraining. And, unless you give money to places suffering this form of shortage, they certainly will not have any incentive to upgrade their curriculum standards when they know it will simply exaggerate their staffing problems. Unless the Federal Government can put some money behind teacher retraining, all the talk about higher standards and higher graduation requirements can only amount to wishful thinking. We know you recognize teacher training as a priority in the bill. We simply urge that you focus on it more.

Besides the amount of money, the formula issue and the need for a special emphasis on retraining, there are some other suggestions we have. We support the use of competitive scholarships as one way of recruiting new people. We don't think such a program should be simply symbolic. Nor should it have any particular relationship to elected officials, or be chosen by political appointees along with elected officials. The Congressional Scholarship program presented in part B of the legislation is insufficient in terms of numbers and flawed in terms of method. We urge you to consider loan programs that include forgiveness provisions for years served in teaching as one alternative. Of course, a more extensive scholarship program than the one proposed—one based exclusively on merit—would be to our liking as well.

We are particularly pleased to see a provision on summer institutes and workshops for teachers in part B of the bill. Here too, we would like to see more money and are doubtful that the funds provided will have sufficient impact. We would hope funds could be specified for institutes that would meet the unique needs of elementary school teachers.

Likewise, we would urge that some attention to the elementary level be carried through to the section on "Strengthening Educational Research and Development" as well. Why indicate a preference for the secondary level here? We fear you are falling into the pattern of convenience I referred to earlier, and thus may end up ignoring elementary learning which is probably, ultimately, more important.

While considering research, I must point out that it certainly would be helpful to have a clearer picture of how the teacher shortage, teacher recruitment prospects, efforts to upgrade curriculum standards and inservice education actually combine at the local level. No national research we have seen actually gives a good national picture of how these variables interact locally. This is one of the reasons we ended up doing our own spot research. Such information would be very useful to have now when we are grappling with the funds distribution problem. Certainly it should be part of our future deliberations.

Let me conclude by saying that we are pleased the committee is making this effort. We welcome its recognition that solving the math and science problem is a matter for the Federal Government to address. We do not think the amount of money you are considering will be adequate. We do not see that you have any rationale for distributing it, and would urge that you think about putting it in the right places. We believe that the purposes of the bill are too diffuse (especially given the amount of money proposed) and, while we support many of the purposes listed, would urge that you consider focusing them along the lines I have suggested.

We assume you agree with us that the math and science problem is not just a precollege problem and that whether it is the demands of the labor market or of our nation's need for a well-educated citizenry, we should make math and science matters of general concern for all students, future job-seekers and voters alike. This means we require more teachers and higher standards at all levels, from the elementary (even preschool) years right through high school. It is appropriate that the Federal Government help public education with those goals and do it in such a way that the public can see how the money is spent. We believe that what we have suggested makes that more possible.

Thank you very much for considering the views of the American Federation of Teachers, AFL-CIO.

Mr. KOGOVSEK. Thank you.

Mr. WILLIAMS. Mr. Chairman, if I might interject at this point?

Mr. KOGOVSEK. Go ahead.

Mr. WILLIAMS. I realize you prefer to go through the entire panel. However, I must leave for an 11:30 appointment and before I do, I think it is incumbent on me as a member of the AFT to comply with Ms. Kemble's request that we ask her a question.

What is your reaction to the proposals of the Secretary of Education?

Ms. **Kemble**. Thank you very much.

First of all, it is clearly not enough money for all of the reasons I have indicated, even given the focus that he throws out.

Second, it ignores the elementary level, which is a very serious shortcoming.

Third, I think it does not address itself to attract new people.

All the statistics show that the numbers that are being turned out in these two areas have gone down dramatically. In New York State, between 1975 and 1979, they went down something like 66 percent. And the projections for 1980 to 1985 are something comparable to that, in terms of the numbers of math teachers turned out. It doesn't address the recruitment issue.

More importantly I think than any of those points is that it doesn't look at what is happening on the job. We have people now teaching in these areas who are minimally qualified. They may have been math or science minors in college. They may be on temporary emergency credentials, which many school districts are offering, sometimes on the basis of a test taken.

What needs to happen is that these people who are already teaching these subjects need to be fully qualified, or if you have an English teacher, for example—let's take social studies, just to be consistent with this proposal—if you have one of these teachers who has some math courses and these are the ones actually who have some background, who are going to be more likely to want to shift over, they are not going to leave their teaching job in social studies to go off for a year somewhere and take a scholarship. They cannot afford it, for one thing. Teachers salaries are low enough. They certainly cannot afford to go off and not be earning an income for a whole year.

The people on the job I think are the ones, whether they are already teaching the subjects or whether they could be transferred over to teach the subjects, are the ones to address. And that means you need a whole complex of inservice programs. Some of them might involve some leave part time, some of them some afterschool work. But you are not going to be able to have massive numbers of people taking a year to study.

I also might say it has been our experience that once people get laid off from teaching, and I think that is one of the things he was aiming at, they do go look for other jobs. They are very discouraged.

In many of our large cities you have people being laid off and then recalled and then laid off. And the likelihood that laid-off people are going to want to go off and retrain on some kind of a minimal scholarship is very low, I think.

Mr. **Williams**. Thank you.

Mr. **Kogovsek**. I would thank the gentleman from Montana for being with us this morning.

The Chair would now indicate to the rest of the people that we would, before asking any more questions, go through the whole panel, take the testimony, and then if you would be able to be present for some questions that we might have, we would appreciate it.

I would also like to remind the members of the panel that you were asked in your invitation to try to limit your testimony to about 5 minutes. I know that is difficult to do when you have a problem of this magnitude, to try to summarize it in 5 minutes. We won't have a gong to hit you over the head, because this is a very important subject, and probably cannot be handled in 5 minutes. But we do have some time constraints.

At this point we would call on Mr. Richard Johnston, Superintendent of Alamosa Public Schools in Colorado.

STATEMENT OF RICHARD D. JOHNSTON, SUPERINTENDENT OF SCHOOLS, ALAMOSA, COLO.

Mr. JOHNSTON. Thank you, Mr. Chairman.

I am superintendent of a small school in south central Colorado, 2,200 students. For that reason I would like very much to speak for the small rural schools, especially in Colorado.

First of all, I think H.R. 30 is a very good bill. I even think the dollar amount is satisfactory. I say that for these reasons: One is that I really believe that it directs itself to the correct priorities and recognizes the needs that we have. I know you have viewed an awful lot of statistics about the problem, the problem does exist, and probably exists more for rural schools than it does for the large city schools. A quick example.

In 1973 Colorado institutions of higher education graduated 161 mathematics and 168 science teachers. By 1981 there were only 24 math teachers and 73 science teachers. Not all of these graduates elected to go into teaching. Those that did found a ready market for their talents in the big city schools.

We in the rural areas had a very, very difficult time attracting them.

I really believe that until such time that more dedicated people elect to enter the teaching profession in math and science we must provide inservice and retraining to enhance the skills of those currently in our classrooms.

Most of us in school administration have not had extensive training in curriculum development in areas of math and science. I believe that the provisions of H.R. 30 for the development of plans for modernizing these courses will have a significant impact on the quality of programs available to our students.

One of the provisions that we especially like out in the rural part of the country is the provision that allows two or more education agencies to combine funds. We currently do this in a good many areas—especially education, title I, the block grant programs, that we have found that we can deal far more effectively with the issues if we can combine our resources. That is why I say that the amount of money in this bill is probably adequate.

The provisions of the bill that allow for dual enrollments and mobile educational services will also make it economically feasible to expose our rural students to new technology and techniques. Again, together we can do those things that we cannot do individually.

Our schools are moving as rapidly as is economically and educationally feasible to incorporate computer literacy and computer assistance instructions in our schools. However, because of funding limitations and other inhibiting factors, the lack of appropriate high quality software, I would expect that the provisions of H.R. 30 would do much to help us alleviate this problem by enhancing the skills of those teachers who are responsible for the delivery of instruction.

The section 605 that provides State use of funds I think is an excellent provision. I base this on my experience in Colorado.

I am confident any financial support made available to the Colorado Department of Education would be directed toward the enhancement of the quality and quantity of math and science programs in our schools. I know there has been some criticism about these kinds of things, but in Colorado at least our department does its very, very best to direct all available resources directly to the schools.

Section 621 through 623 are extremely important components of H.R. 30. They will provide the incentives for students to enter and remain in the teaching fields of mathematics and science, and they will provide the incentives to institutions of higher education to develop retraining programs for our teachers.

I guess to summarize, there needs to be a concerted effort on the part of schools, business, and government to bring about a public awareness of the critical needs for improving the quality of mathematics and science education in our schools. In reviewing curriculum for the past few years, I have found that our schools have not reduced curriculum, at least those that I am familiar with.

What we have found, however, is that the public awareness of the need for math and science has gone down a great deal, and students and parents have not recognized how valuable these courses are. As a result, students have not enrolled in them.

I believe, if nothing else, H.R. 30 will call public attention to the great need for science and mathematics. I think you will be well rewarded to see the impetus that this adds to math and science in our schools.

I am delighted that you have identified the appropriate priorities, and that you are providing the support our schools need to improve science and math in our schools.

Thank you.

Mr. KOGOSVEK. Thank you very much for your testimony.

[Prepared statement of Mr. Johnston follows:]

PREPARED STATEMENT OF RICHARD D. JOHNSTON, SUPERINTENDENT OF SCHOOLS, ALAMOSA, COLO.

Mr. Chairman and Members of the Subcommittee: I am Richard Johnston, Superintendent of Schools in Alamosa, Colorado. Alamosa is a rural community located in the San Luis Valley in the South-Central part of the state. Our public school enrollment is 2,200 students in grades Kindergarten through 12. Many school districts in the State of Colorado are very small and isolated. In the area I represent we have some isolated schools with less than 200 students in the entire K-12 system.

I believe you have heard, or will hear, testimony from several large urban and suburban school districts and I would, therefore, like to speak primarily in behalf of the smaller rural districts, though I am equally concerned with the education of all children attending our nation's schools.

I agree that the level of mathematical and scientific literacy has declined in recent years and I commend the efforts of this committee to provide direction, leadership and support in our efforts to reverse this trend. Reliable statistical data is available from several sources to prove that the problem does exist and I would like to confine my remarks to my perceptions of how H.R. 30 will help the small rural districts meet the challenges we face.

First of all, rural schools face a serious problem in securing qualified mathematics and science teachers. In 1973 Colorado institutions of higher education graduated 161 mathematics and 168 science teachers. In 1981 there were only 24 and 73 graduates in these fields. Not all of these graduates elected to go into teaching and those that did found a ready market for their talents in the larger city districts. Section 604 of H.R. 30 will be of major assistance in helping rural schools deal with the scarcity of qualified teachers. Until such time that more dedicated people elect to enter the teaching profession in Math and Science, we must provide inservice and retraining to enhance the skills of those currently in our classrooms. Not enough opportunities currently exist for teachers to upgrade their knowledge and skills with respect to new scientific and technological advances. H.R. 30 can provide the incentive to begin development of additional programs for this inservicing and retraining of teachers.

Advances in computer technology and modern electronics, the need for curricula to reflect a variety of student needs and the necessity of incorporating technical topics for other professions and societal applications dictates that we revise and revitalize the mathematics and science curriculum. Many of us in school administration have not had extensive training in curriculum development in the areas of mathematics and science. The provisions of H.R. 30 for the development of plans for modernizing courses of instruction in mathematics and science will have significant impact in the improvement of the quality of programs available to our students.

The provisions of H.R. 30 authorizing two or more educational agencies to combine funds is especially beneficial to smaller schools. Those of us in the rural communities of Colorado are prepared to combine resources and cooperatively deal with those issues that we cannot effectively deal with as individual districts. As a result of financial restrictions, many of our schools are unable to provide up-to-date laboratory equipment and exposure to recent technical developments. The provisions of the bill allowing for dual enrollments and mobile educational services will make it economically feasible to expose our rural students to new technology and techniques. We cannot train students for participation in a complex society with apparatus that is obsolete or, in some cases, non-existent. The smaller rural schools often do not have access to the technology of modern industry and the cost for a single school to provide exposure to this technology is generally prohibitive. Most of the schools in Colorado belong to educational cooperatives and, if financial support is available, we could, and would, combine our resources for maximum impact.

The application of computers for instruction is an important consideration. Computers do have the capacity to reshape traditional education delivery systems. Their proliferation in all aspects of today's society makes it essential that our students have an understanding of their use and application. Our schools are moving as rapidly as is economically and educationally feasible to incorporate computer literacy and computer assisted instruction into our schools. In addition to funding limitations, another inhibiting factor is the lack of appropriate high quality software. I would expect that the provisions of H.R. 30 would do much to help us alleviate this problem by enhancing the skills of those teachers who are responsible for the delivery of instruction. On a cooperative basis, many of us are working with the Minnesota Educational Computer Consortium in the development of high quality instructor developed software. We have made a start but we need to do much more and H.R. 30 could be an important catalyst.

Section 605, providing state use of funds, is an excellent provision. The Colorado Department of Education does an outstanding job of providing leadership and technical assistance when they have access to financial and human resources. Colorado, which is apparently not unique, has been forced to make substantial reductions in all departments of State Government. My experience, however, indicates that the Department of Education is still deeply committed to providing services to the schools and children of our state. I am confident that any financial support made available to the Colorado Department of Education would be directed toward the enhancement of the quality and quantity of math and science programs in our schools. Just recently the Department organized a state-wide mathematics task force committee. It is my pleasure to be a member of this task force and we are currently studying math programs for Kindergarten through University level with the goal of making recommendations for improvement.

During the 1960's I served as a school administrator in both North Dakota and Minnesota. Our country was moving rapidly into the space age and we were witnessing the beginning of a new age of technology. During those years most of my math and science teachers participated in the summer institutes conducted through the National Science Foundation. I am convinced that this program was one of the most productive and profitable programs funded by the Federal Government for education and our Nation. Unfortunately, it was not continued and many teachers teaching today have not had access to these high quality retraining programs.

Sections 621 through 623 are extremely important components of H.R. 30. They will provide the incentives for students to enter and remain in the teaching fields of mathematics and science and they will provide the incentives to institutions of higher education to develop retraining programs for our teachers.

In closing, it is obvious that our schools are facing a serious shortage of qualified mathematics and science teachers and the problem is even more acute in our small rural schools. Until such time as more qualified people enter the teaching profession we need to upgrade the skills of those now teaching mathematics and science in our classrooms and retain others. Institutions of higher education must develop programs to help meet this need and it is essential that programs be initiated to encourage highly skilled people to enter the profession.

In many cases the content of our mathematics and science programs is inappropriate for meeting the demands of our technological society. There is a need for curriculum revision and revitalization. New curricula must reflect societal and technological changes that have occurred in recent years and this curricula must provide a solid foundation for all students in order that they may cope with the complexities of tomorrow's society.

And lastly, there needs to be a concerted effort on the part of schools, business and government to bring about a public awareness of the critical need for improving the quality of mathematics and science education in our schools.

The problems of securing skilled teachers and improving the quality of our mathematics and science programs affect schools nationwide and resolution of these problems requires government leadership and support. H.R. 30, the "Emergency Mathematics and Science Education Act" identifies the appropriate priorities and provides the support our schools need to improve elementary, secondary and post-secondary education in mathematics and science.

Mr. **Kogovsek**. The Chair recognizes Mr. Robert C. Bowen, vice president, marketing, McGraw-Hill.

Mr. Bowen is to be accompanied by Mr. Roy Millenson.

STATEMENT OF ROBERT C. BOWEN, VICE PRESIDENT, MARKETING, McGRAW-HILL, REPRESENTING THE ASSOCIATION OF AMERICAN PUBLISHERS, ACCOMPANIED BY ROY H. MILLENSON, DIRECTOR OF EDUCATION & LIBRARY AFFAIRS

Mr. **Bowen**. Thank you, Mr. Chairman.

I am here today in my capacity as chairman of the School Division of the American Associate Publishers. We are a general association made up of some 300 member publishers producing the vast majority of trade, educational, professional, and religious books used in our Nation's schools and libraries today.

The AAP School Division is comprised of publishers furnishing instructional materials to our elementary and secondary schools. These include textbooks, audio-visual supplements, teacher resource books, and other components needed to provide a comprehensive instructional program. Our publishers also provide a vast array of consultive services through hundreds of staff educational consultants who are experts in their disciplines. All have been classroom teachers and many have been curriculum supervisors in local school districts.

I also had the fortune to serve on the Office of Technology Assessments' Educational Advisory Committee and was a contributor to the recent information technology and its impact on American education.

By education I am an educator, having served as a high school math and science teacher, counselor, and later as a district administrator. I also would like to mention that my undergraduate degree was funded through an NDEA-sponsored student loan. So I hope that my limited success is testimony to that funding. I do appreciate it.

It is from these responsibilities, education and work experience that I am pleased to speak about this legislation, and its importance.

With your permission, I would just like to summarize and highlight and personalize this written testimony.

EFFECTIVE MATH AND SCIENCE INSTRUCTION

First of all, looking at the quality of instruction and achieving effectiveness in instructional programs, particularly in math and science, there are three critical elements to accomplish that task.

First, as we all well know, is the teacher, the focal point. Without quality teaching we are not going to get improvement or any change in our math and science education. And I hope as we consider the various proposals that we will not get into a numbers game in terms of recruiting and bringing teachers into our classrooms, simply filling up slots. I think that would be a tragic mistake and will not get the quality we need.

Second, there is the school administrator. His leadership is paramount in getting improved quality in our educational program. And that goes for both the elementary and secondary level.

Finally, there are the basic tools that a teacher works with and the students interact with on a day-to-day basis, and that is instructional materials. I won't go over all the statistics. I know that it has been presented to you and you have seen the teacher shortage and the quality of instruction. But I would like to emphasize the dire need of in-service training for teachers and reemphasize what has already been said here today.

NEED FOR TEACHER TRAINING

There is a great lack, because of the current funding crisis, for adequate training of teachers and upgrading of their skills. Even when publishers offer free programs, it is very hard for teachers to secure the needed release time to attend those sessions. We are now forced into short after-school sessions to try to upgrade those skills or to cover new text material that they are introducing into their classroom.

Anyone that has taught 6 hours during the day with a group of students knows how draining that is, and then to try to crowd in a few hours after school is inadequate. We need the time available and the teachers need the time in order to upgrade their skills. The same goes for school administrators.

If we are to deal with this problem, the school administrator must be the instructional leader and must be aware of the current problem and must be committed to addressing the math and science needs of their students.

NEED FOR INSTRUCTIONAL MATERIALS

Finally, the instructional material has fallen victim to the same problems in terms of funding. Just a few quick statistics.

Textbooks have declined as a percentage of the total spent on education by 50 percent since 1965, so it is not a recent problem. Less than 1 percent of the educational budget has been on instructional material, but 95 percent of the academic time of teacher and student is spent with these instructional materials. It is critical that the current legislation address the adequacy of the instructional tools that teachers deal with as well as adequate time for upgrading the school through the necessary training. Now, some of the specific proposals that we are suggesting.

First of all, I question whether the current shortage we are dealing with in teachers is going to be quickly remedied and we are going to see a turnaround very rapidly; I don't believe that is going to be the case. So we have to look at ways of extending the reach of our most talented teachers. There are plenty of them there, even given the current crisis.

I believe the new technologies, the microcomputer and the video tapes or discs, seem to offer the greatest promise. But the great stumbling block is quality, course-ware, and integrated software. It costs a great deal of money. Even though the equipment is coming into schools in vast numbers, the microcomputers particularly, the development of the software necessary to accompany and make useful those tools to teachers and administrators is very, very expensive, and it will need to be relieved.

I am encouraging this be done through a consortia of the private sector, the academic community and the local school districts. The focus should be on comprehensive instructional material programs rather than just course-ware for the technology.

Second, we need resources, as I mentioned, to make the necessary available in-service programs to the reach of teachers, to every teacher, every math and science teacher, and to the administrator.

NEED FOR RESEARCH

Finally, basic research is needed to insure the effectiveness and to incorporate the new technology into our math and science programs. We need research and the best instructional uses of this technology: what kinds of print material is needed to complement the technology, and how students learn through the use of the technology and how cost-effective are such programs. If they are going to be implemented on a wide scale, they must be cost-effective for the local districts or we will simply lay a burden on them they cannot continue to bear, and finally, how this curricula can best be presented in using the new instructional materials.

This research should again be supported by consortia from the private sector, the academic community and the local district.

If I could, Mr. Chairman, I would like to ask my colleague to comment on some of the technical aspects.

Mr. MILLENSON. Mr. Chairman, I shall be very brief.

I am speaking to page 4 of the AAP testimony, which I understand will be in full in the record.

FOUR-YEAR AUTHORIZATION

We urge a 4-year authorization of this legislation. H.R. 30 provides 2 years. With the administration's bill itself, as the Secretary testified, being 4 years, I think the committee would be exhibiting an excess of reticence if it had only a 2-year bill. A 4-year bill is important. The NDEA, when it was first enacted, which has just the same purposes as this legislation, was also 4 years.

CONSULTATION WITH COHEN AND RICHARDSON

We note on page 5 of our testimony that Wilbur Cohen, after he had served as Assistant Secretary of HEW for Legislation and as Secretary of HEW, testified in the Senate on the importance of letting the school district and the department have sufficient time to prepare time for planning.

In this connection, we would like strongly to urge that the committee consult with both Wilbur Cohen, the former Secretary of HEW, and Elliot Richardson, who was Assistant Secretary of HEW for Legislation at the time NDEA was written and who participated in its writing, and also helped in its early administration. Consult with both of these gentlemen, because what you have here is landmark legislation. I think their wisdom and their experience would be very helpful to the committee in casting whatever is finally written.

SUPPLEMENT, NOT SUPPLANT

Finally, Mr. Chairman, here on page 5 we have what appears to be minor proposals under the heading "Other Provisions." But I think they are in effect major if this legislation is to be effective.

We urge, number one, that there be language very clear in the bill that is reported out that Federal funds be used to supplement, not supplant, local expenditures.

MAINTENANCE OF EFFORT

We all know that our local school districts and our States are hard up. They should not use the Federal money provided for this emergency math and science program to just take care of their ordinary expenditures or for the expenditures which are being cut back. In this connection, we strongly urge a maintenance of effort provision be included in the bill. Now, you and I know that maintenance of effort is not the easiest thing to oversee. But it is most important if any Federal program is to be effective, a program which adds to what is now being done rather than just merely gives monetary relief to hard-pressed school districts.

Thank you, Mr. Chairman.

Mr. KOGOVSEK. Thank you, Mr. Millenson.

Thank you, Mr. Bowen.

[Prepared statement of Robert Bowen follows:]

PREPARED STATEMENT OF ROBERT C. BOWEN, CHAIRMAN,[1] SCHOOL DIVISION, ASSOCIATION OF AMERICAN PUBLISHERS

My name is Robert C. Bowen, I am Vice President and General Manager of the Gregg Division of the McGraw-Hill Book Company, and am here today in my capacity as Chairman of the School Division of the Association of American Publishers (AAP), testifying in behalf of that division. I might add that I was also a contributor to the recently-issued report on "Informational Technology and Its Impact on American Education" by the Office of Technology assessment of the U.S. Congress.

The AAP is the general association of book publishers in the United States. It comprises professional and scholarly publishing; college; international; direct market/book club; school; and general publishing divisions. Our some 300 member publishing houses produce the vast majority of trade, educational, professional and religious books published in this country and found in the nation's libraries and schools, as well as related audio-visual materials. The School Division comprises houses furnishing instructional materials to public and private elementary and secondary schools.

INTRODUCTION

The legislation before us (H.R. 30), like the National Defense Education Act of 1958 to which it is an amendment, is designated as emergency legislation. This is fitting, as the first paragraph of NDEA states:

> SEC. 101. The Congress hereby finds and declares that the security of the Nation requires the fullest development of the mental rsources and the technical skills of its young men and women. The present emergency demands that additional and more adequate educational opportunities be made available. The defense of this Nation depends upon the masters of modern techniques developed from complex scientific principles. It depends as well upon the discovery and development of new principles, new techniques, and new knowledge.

With this in mind, our recommendations here today are not directed toward specific comprehensive and long-term legislation, but rather legislation to achieve an early beginning to solving current problems while also being sensitive to the exigencies of the Federal budget and the crisis of the faltering national economy.

NEED FOR EDUCATION INSTRUCTIONAL MATERIALS

The terms "software" and "instructional materials" are often used interchangeably and loosely. To be used successfully in an elementary or secondary school, the new technology requires not only discs, chips and other similar materials and equipment but also requires complementary printed instructional materials, such as textbooks, manuals and workbooks.

Any legislation approved by this committee, therefore, should employ the more inclusive term "instructional materials" which encompasses both the materials used in the computer itself and the necessary complementary materials referred to above.

The October, 1982 report of the National Science Board Commission on Precollege Education in Mathematics, Science and Technology, "Today's Problems; Tomorrow's Crises," after recounting the teaching potential of the new technology, adds a cautionary note: "However, computer software is generally inadequate, and the full potential of these technologies for instruction has received little attention."

The Office of Technology Assessment, in its report, "Information Technology and Its Impact on American Education," proffers a similar conclusion: "OTA found that the most-often cited barrier to current educational use of technology was the lack of adequate educational software."

The cost of developing instructional materials to be used with the new technology is very high. Some companies have invested as much as $1.5 million in their computer software programs. Small companies are consequently often discouraged from entering the field. In addition, larger firms are reluctant to risk substantial sums in enrollment areas which have a relatively smaller number of students.

A principal conclusion of the January, 1981 Report of the U.S. Department of Education Task Force on Learning and Electronic Technology stated:

> Many private sector companies have made tentative forays into developing technological products and services for education. The outlook for future efforts to

---

[1] Mr. Bowen is accompanied by Roy H. Millenson, AAP Director of Education & Library Affairs.

expand the impact is not bright, largely because education systems provide few significant incentives to private-sector entrepreneurship in this area.

This finding impelled the following recommendation:

The Department should provide incentives to encourage private-sector/university combined efforts to develop exemplary "high quality" software for computers and videodiscs. This should be done in cooperation with school districts and state education agencies that elect to participate in such ventures. The purpose is to get all involved in making the trade-offs that will be needed to successfully implement the new technologies in instructional settings.

We also cite the December, 1982 policy paper of the Council of Chief State School Officers, "Need for a New 'National Defense Education Act' " which stated:

The fields of mathematics and science are particularly vulnerable to the rapid obsolescence of instructional material. Allowable expenditures under any federal program should include assistance to school districts to maintain reasonably up-to-date texts and library resources. School districts and states could use funding to meet their needs, including at least:

New science and math sequences which match the stages of children's intellectual development;

Updated curricula which accommodate technological and social changes; and

New mathematics and science equipment, including computer hardware and software.

In the light of the foregoing we urge that prime emphasis be given to the development of high-quality courseware, embodying both the latest knowledge and techniques, and involving, as the Department of Education Task Force report suggests, the combined efforts of the private sector and the academic community.

PRIVATE SECTOR PARTICIPATION

Congress recognized the importance of private sector participation in the development of instructional materials and curricula when in 1978 it added subsection (c) to Sec. 426 of the General Education Provisions Act (GEPA), the law which now applies to all Department of Education programs. The pertinent portion of that subsection reads as follows:

(c) In awarding contracts and grants for the development of curricula or instructional materials, the Commissioner and the Director of the National Institute of Education shall—(1) encourage applicants to assure that such curricula or instructional materials will be developed in a manner conducive to dissemination through continuing consultations with publishers, personnel of State and local educational agencies, teachers, administrators, community representatives, and other individuals experienced in such dissemination;

A reference to this provision in the committee's report would serve to remind the executive department that Sec. 426(c) of GEPA is still very much viable. This provision has proven successful and has, I understand, helped avert the development of materials which are never used.

Just as the private sector has a recognized and proper role in the development of instructional materials and curricula, so it also has a role in the training of teachers in the use of such instructional materials and curricula. As a matter of long practice, publishers provide in-service training to teachers in the use of texts and workbooks which the school system has obtained from them. Such expertise should continue to be utilized.

BASIC RESEARCH

The OTA report found that "to make the most effective use of technology, there was a need for R&D in learning strategies and cognitive development, methods for the production of effective and economical curricular software, and the long-term psychological and cognitive impacts of technology-based education. It is worthy to note that, based on the foregoing, OTA urges that "Congress should consider policies to: "(1) directly support R&D in these areas, "(2) encourage private sector investment from both foundations and industry, or "(3) encourage a combination of both by using Federal funding to leverage private investment."

The new Section 624 of NDEA to be added by Sec. 2 of HR 30 provides one opportunity to realize these recommendations. However, rather than just suggesting some studies that might be undertaken, the legislation should require such studies. Chief among the items to be mandated should be:

1. Research on the instructional uses of the new technology.
2. Research on what kinds of instructional materials should be developed to work with the new technology.

3. Basic research on how students learn through use of the new technology.
4. Research on how curricula can best be presented using the new technology and complementary instructional materials.

This research is in keeping with the intent of Congress as set forth in Section 405(a)(2) of the General Education Provisons Act which states that "The Congress further declares it to be the policy of the United States to . . . help to solve or to alleviate the problems of, and promote the reform and renewal of American education . . ." and to "strengthen the scientific and technological foundations of education . . ."

FOUR YEAR AUTHORIZATION URGED

We urge that authorizations be for four years, rather than the two years specified in the Emergency Mathematics and Science Education Act (HR 30).

When the National Defense Education Act (NDEA) was first enacted as Public Law 85-864 in September of 1958, the authorization for the elementary and secondary education programs in it was for four years. A rereading of the Findings and Declaration of Policy (Sec. 101) of that statute—which is quoted at the beginning of this testimony—will reveal that NDEA had similar objectives to HR 30.

Furthermore, in his landmark testimony before the Senate Education Subcommittee, Dr. Wilbur Cohen, looking back upon his tenure as Secretary of HEW and Assistant HEW Secretary for legislation, indicated that a paramount lesson learned from that experience was that education aid programs should be allowed sufficient time for planning and getting under way and should not be started with little preparation and at full speed.

OTHER PROVISIONS

Federal education aid programs traditionally include a provision that Federal funds should supplement, not supplant, local and state expenditures. This has the effect that the Federal funds provide education aid, not mere financial aid. Such a provision should be included in any bill reported by the committee.

Similarly, a maintenance of effort provision should be included. If a deficit-burdened Federal Government is expected to expend scarce financial resources to assist local and state education efforts, then the least that should be expected of such states and localities is that they maintain their own level of expenditures.

CONCLUSION

This testimony has been submitted with a sensitivity both to the need for budgetary restraint and the equally great need for a technologically literate and knowledgeable citizenry.

the report of the NSF study commission is aptly titled "Todays Problems; Tomorrow's Crisis". What the Congress now does will bear either a title of "Today's Solutions; Tomorrow's Successes" or "Today's Neglect; Tomorrow's Failures". We opt for the former.

Mr. **Kogovsek**. We will now proceed to Mrs. Helen Washburn, president of the American Personnel and Guidance Association.

STATEMENT OF HELEN R. WASHBURN, PRESIDENT, AMERICAN PERSONNEL AND GUIDANCE ASSOCIATION

Ms. **Washburn**. Thank you, Mr. Chairman.

I am Helen Washburn. I have spent my career initially as a senior high school science teacher and a counselor in the public schools of Boise, Idaho. I am speaking on behalf of the American Personnel and Guidance Association as its president. We are an association of nearly 41,000 members, serving as practicing counselors and counselor educators.

With your permission, Mr, Chairman, I would like to submit to you and the committee an expanded written testimony and accompanying publication entitled "Why Counseling?" This publication contains, among other things, the history of NDEA and the role school counselors played in helping our Nation during that era and also documents the effectiveness of counseling services.

Mr. KOGOVSEK. Without objection, that publication will be made a part of the record. [Retained in subcommittee files.]

While I have interrupted you, let me also indicate without objection everyone's written testimony will be made a part of the record.

Please proceed.

Ms. WASHBURN. I will now highlight several points presented in the written testimony.

The American Personnel and Guidance Association wishes to go on record in support of the importance of current congressional deliberations on legislation emphasizing better mathematics and science instructions in schools and also better preparation of teachers for the instruction of mathematics and science.

We believe, however, that improvement of mathematics and science instruction is just a small part of the solution to a very complex and long-term problem, which is adequate preparation of all of our young people to accommodate to a different work world than has existed in the past.

Students need to understand that mathematics and science courses are going to be useful to them. Students with exceptional abilitites and talents for science and technological careers need to be identified, and all students need assistance in making decisions about their place in the work world of the future.

Our association hopes that the Congress, when dealing with America's technology question, will address the central role which professional counselors play in advising students in their career development, assisting teachers and administrators in curriculum improvement, and creating awareness in parents and youth about the employment needs of business, industry and the military which utilize high technology.

To this end the American Personnel and Guidance Association would like to recommend that provision for the following be included in the legislation under consideration:

Inservice training for existing guidance practitioners, supervisors and trainers.

Two, preservice training of counselors, counseling and guidance personnel currently working in schools, and higher education must be given a variety of opportunities to become familiar with the technological employment opportunities in business, industry and the military. Counselors must also be trained to understand emerging technology and equipment and the talents and skills required for those careers so they are able to counsel, inform and advise people for a high technology society.

Three, labor information and labor projections. Current and appropriate labor information must be compiled by industry and government and supplied to counselors.

Four, and finally, research and evaluation. Research is needed on effective data-gathering assessment, goal-setting, and information dissemination techniques. Evaluation on the efficacy of counselor practice and guidance services for helping to achieve national priorities is also needed.

The above four recommendations constitute the American Personnel and Guidance Associations recommendations as to how H.R. 30 might be expanded and improved to include a counseling component which does not now exist in this legislation. That is vitally needed for the success of this nation's effort to better prepare youth and adults for living in a technological society.

Mr. Chairman, members of the committee, I wish to thank you for giving me the opportunity to speak and to submit testimony on behalf of APGA. I stand ready to answer questions which you might have about my testimony.

[Prepared statement of Helen Washburn follows:]

PREPARED STATEMENT OF HELEN R. WASHBURN, PRESIDENT, AMERICAN PERSONNEL AND GUIDANCE ASSOCIATION

Mr. Chairman and members of the U.S. House of Representatives Subcommittee on Elementary, Secondary and Vocational Education and the Subcommittee on Postsecondary Education, my name is Helen Washburn. I have spent my career initially as a senior high science teacher and more recently as a counselor in the public schools of Boise.

Today I am speaking on behalf of the American Personnel and Guidance Association as its President and long-time member of the community of professional counselors APGA represents.

It is an understatement to say that our nation is facing extremely challenging times during this decade of the 1980's. There is a substantial number of significant national needs to which we must respond in a short period of time if our nation is to continue to prosper. These needs include productivity and economic revitalization, employment opportunities for our citizenry, equality of opportunity, and adaption of our human resources to the use of our increasingly complex technological resources.

The Emergency Mathematics and Science Education Act is a needed effort to confront these needs. I appreciate the opportunity to meet with you today to present my views on this national legislative proposal.

The situation in which our country finds itself today is not dissimilar to conditions which confronted it in the late fifties. Education responded then and we can respond again. A question we must ask ourselves, however, is, how can we best use the knowledge we gained from that previous experience and apply it to the problems of this decade.

The National Defense Education Act of 1958 resulted in a variety of outcomes. For our profession and our Association it meant a growing acceptance of school counselors as major contributors to the education process when they helped the United States achieve in the 1960's and 1970's the scientific goals which were implicit in the original NDEA legislation.

The financial resources provided through the NDEA legislation, various amendments to the Vocational Education Act of 1363, and the Elementary and Secondary Education Act made possible the expansion of counselor training opportunities and research programs to study effective methods for delivery of counselor services, measurement of individual characteristics and career behavior.

Evaluators concerned with the effects of government spending in support of guidance and counseling have produced studies showing positive effects. For example, the 1975 annual report from the U.S. Office of Education, Educational Programs That Work, listed more than a dozen different counseling programs that had been evaluated by outside evaluators as being effective (U.S. Department of Health, Education and Welfare, 1975). In Innovative Educational Practice, six effective counseling programs validated by Elementary and Secondary Education Act Title III evaluators were listed (U.S. Department of Health, Education and Welfare, 1974). Similar findings have been reported in documents published by the Office of Education, the Rehabilitation Services Administration, and the Department of Labor.

Further documentation on the positive effects of guidance and counseling on decision making abilities, career development and planning, school achievement and transition to work and work adjustment was summarized and submitted in testimony by Edwin L. Herr in testimony before the U.S. Senate Labor and Human Resources Committee, Subcommittee on Education, Arts and Humanities on April 28, 1982. (See copy of the attached monograph)

From the accumulated data, we have learned that guidance and counseling has an important personal growth and development emphasis. We have also learned that well-designed, thorough and systematic guidance programs utilizing trained, competent professional counselors have implications for effectively increasing America's human capital.

Career guidance and delivery of career information is done most effectively when it is incorporated into elemetary education and not left to the last one or two years of schooling. Elementary counselors working directly with students and parents or working indirectly by serving as a consultant to teachers can enhance childrens' career development.

Assessment of students' aptitudes, skills and talents, meaningful interpretation of assessment results to students and parents, and assistance in applying that information to course selection and career decision-making helps students make more informed and appropriate career choices. School counselors have a long history of effectively providing these services.

The American Personnel and Guidance Association (APGA) wishes to go on record in support of, and in recognition of, the importance of current Congressional deliberations on legislation which emphasizes better mathematics and science instruction in the schools, and better preparation of teachers for the instruction of mathematics and science.

We would also like to go on record as believing that the legislation is a short range solution to a more complex and long term problem which is adaption by all students to a new technological age. We believe that the need exists for adequate preparation of all our young people to accommodate to a different work world than existed in the past. We have an obligation to prepare them to cope with that different world and to use the new technological tools that now exist or will be developed in the future.

Counselors can help in such an adaptation by:

1) Assessing and identifying all students talents, skills and abilities and assisting them to investigate school courses and career opportunities which enhance those personal characteristics.

2) Providing information to students who possess exceptional abilities in the areas of math, science, mechanics and spacial relations abstract-reasoning to pursue professional and technical careers which utilize those skills for the benefit of our country's defense and industrial needs.

3) Assisting students in planning not only for a "first job" but also preparing them to anticipate several changes and transitions in their lives as our technological world continues to develop.

4) Encouraging students to pursue other courses in addition to math and science so as to provide a work force which can communicate adequately utilizing effective listening, speaking, and writing skills.

5) Building into students school experiences opportunities to learn about transition to work, personal commitments to work, and ways of deriving feeling of psychological competence in the work place.

6) Training young workers in job-search and interview skills and human relations so successful transition from school to work will occur.

7) Working with students and with their teachers to assist such young people to overcome resistance to mathematics because of their fear of lack of success.

8) Identifiying minorities and women who demonstrate interest and aptitudes for math and science and encouraging them to pursue advanced study and preparation to follow nontraditional jobs such as engineering and physics where talents are so urgently needed.

The Association is confident that the Congress will give careful attention to the need for more technicians, mathematicians, scientists, and engineers.

We hope that the Congress when dealing with the technological question will address the central role which professional counselors play in advising students in their career development, assisting teachers and administrators in curriculum improvement and creating awareness in parents and youth about the employment needs of the business, industrial and defense establishment which utilize high technology. The counselor and strengthened guidance and counseling programs provide a structure for this to occur.

To this end, the American Personnel and Guidance Association would like to recommend that provisions for the following be included in the legislation under consideration:

1. IN-SERVICE TRAINING OF EXISTING GUIDANCE PRACTITIONERS, SUPERVISORS AND TRAINERS

In-service training of counselors should emphasize the intermediary role counselors play in bringing together teachers, parents, students and the community. Counselors must be given a variety of opportunities to become familiar with the technological employment opportunities in business and industry and in the military as well as technology needs of these employers so as to better inform and advise students, teachers, administrators and parents. Hands on experiences, summer institutes, exchange programs and paid internships within industrial and military settings are some possible ways of accomplishing this goal.

The emphasis throughout any in-service program should be the counselor's role in maximizing the potential of all youth, especially through early intervention programs in elementary school and continuing on through high school and college. Attention should be paid to the reduction of any job bias in counselors based on personal attitudes. Also, the in-service training should further those counseling skills and techniques which are free of any stereotypes (e.g. race, sex, culture).

In-service and re-training programs for counselors and other guidance specialists should stress skill development in non-school setting work. Examples of in-service programs might include those which develop counselor skills in working with clients, in the community or industry, experiencing job obsolescence or who need redirection of career development; those who are second careerists or returning to the work force; and those experiencing job dissatisifaction or needing advice on re-training for emerging new job clusters. This area is fertile ground for cooperative efforts between schools and industry and/or assistance from private industrial councils.

2. PRE-SERVICE TRAINING OF COUNSELORS

Encouragement and incentives must be provided to institutions of higher education, by the legislation, which experiment with changes and curricular modification in the counselor education preparation program. Internships and practicum situations which have components giving experience working in nontraditional settings (e.g. business, industry, military) must be piloted. Course work which emphasizes occupational and educational information, emerging technological and business trends should be integrated into the core curriculum preparing counselors. The creation of counselor sub-specialties for direct employment in industrial and technological settings should be encouraged legislatively. Counselors should be trained to understand emerging technology, equipment and talent/skills necessary so they may counsel, inform, and advise people for a high technology society. Experiences with computer assisted guidance, occupational information and retrieval systems and use of new methods of assessment and evaluation are essential to such training.

In addition, counselor training should have a strong component which focuses on skills in networking; in coordination of diverse groups; in consultative techniques for working with teachers, parents, administrators; and on skills and techniques for utilization of community resources.

3. LABOR INFORMATION AND PROJECTIONS

Current and appropriate labor information must be compiled by industry and government and supplied to counselors. Such information is vital in assisting students in career choice to assure them finding a place in the work force. The capabilities of high technology must be tapped to provide such information accurately and efficiently. Resources must be so that they can have access to such equipment. Resources must all be made available so that counselors and school personnel become literate about the capabilities of such equipment and trained in their use.

4. RESEARCH AND EVALUATION

The legislation should further and encourage through grants, fellowships and special programs, research on new techniques, practices and programs, which increase the counselor's knowledge and skills in unlocking the potential of all youth and adults. Our citizens must attain maximum personal and career fulfillment if this nation is to achieve its employment policy goals and insure national security.

More research is needed on effective data gathering, assessment, goal setting and information dissemination techniques. Research is also needed on early intervention counseling strategies with children as these concern educator preparation and in-service education need to be initiated which emphasize nontraditional programs, internships, practica and placements.

Evaluation devices, both periodic and long range, need to be tested to determine the efficacy of any modifications in training, re-training and practice as such concern improved counselor performance in achieving national priorities.

The above four recommendations constitute the American Personnel and Guidance Association's recommendations as to how H.R. 30 might be expanded and improved to include a counseling component which does not now exist in this legislation but is vitally needed for the success of this nation's effort to better prepare youth and adults for living in a technological society.

Mr. Chairman, members of the Committee, I wish to thank you for giving me the opportunity to speak and to submit testimony on behalf of the American Personnel and Guidance Association. I stand ready to answer any questions which you might have about this testimony.

Mr. KOGOVSEK. Ms. Dorothy Blake, president, American Association of School Librarians.

Please proceed.

STATEMENT OF DOROTHY W. BLAKE, PRESIDENT, AMERICAN ASSOCIATION OF SCHOOL LIBRARIANS AND COORDINATOR OF PLANNING FOR MEDIA RESOURCES & UTILIZATION, ATLANTA PUBLIC SCHOOLS

Ms. BLAKE. Thank you, Mr. Chairman and members of the subcommittee.

My name is Dorothy W. Blake. I am coordinator of planning for Media Resources and Utilization for the Atlanta Public Schools. Needless to say, I come from a large urban school system. However, many of our problems are just the same as they are in small public school systems.

I am president of the American Association of School Librarians, a major division of the American Library Association. I appreciate this opportunity to testify in support of H.R. 30, the Emergency Mathematics and Science Education Act on behalf of the American Library Association, a nonprofit educational association of almost 40,000 librarians, school library media specialists, library trustees, and public-spirited citizens dedicated to the development of library and information service for all the American people.

I would like to add an aside, that I speak from the experience of a mother, a grandmother, the wife of a school principal, the wife of a former science teacher, and after three decades in the school business I consider everybody who works as a part of the instructional team those who have answered a very high calling. And with that background, I would like to proceed.

At the midwinter meeting in San Antonio, the American Library Association Council passed a resolution, which is attached to my testimony, encouraging Congress to give particular attention to the critical role that library and information services play in the improvement of mathematics and science education at every level in considering H.R. 30. ALA and AASL support the bill as a flexible vehicle for responding to congressional concern about mathematics, science, and technological education. We have some suggestions that we think will improve the bill's response to the explosive developments in electronic information technologies noted by the Office of Technology Assessment in its September 1982 report entitled "Informational Technology and its Impact on American Education."

We agree with the emphasis in the OTA report on the importance of information technologies, their growing use throughout society, their significant promise of a mechanism for responding to the education and training needs of society and their growing importance to education and to our economy.

The important information revolution, according to OTA, is creating new stresses on many societal institutions, particularly those such as public schools and libraries, that traditionally have borne the major responsibility for providing education and other public information services.

Improvement of scientific and technological education cannot take place without supportive library resources that are up to date, both in form and content. Not only must library resources be current with the latest developments and advances, but they must be available in the most useful and appropriate technological format.

That ties in very well with the comments made by Mr. Bowen.

Elementary and secondary school students as well as their teachers must learn to use newer technologies, such as microcomputers and/or computer terminals, not only to solve mathematics and science problems, but also to gain access to information needed for their education and for their work and for daily living.

Much needed information, whether by access to the literature of the specific subject field, or in community information resource files, will increasingly and often exclusively be available on line rather than in traditional printed form.

School librarians and media specialists need training to evaluate and select new resources and equipment for schools and libraries, and in training to assist students and teachers in the use of such resources. Computers are needed in the library as well as in the classroom. Just as the library or learning resources center is central location for materials in both print and nonprint format, it is the logical location for computer software and selected accompanying hardware as well as access to online data bases.

As a part of my testimony, I would like to add a brief survey of one page that will give you an overview of the number of microcomputers available in our schools.

Mr. Kogovsek. Without objection, that will be made party of the record.

[The information referred to follows:]

Student Use of Computers in School

About one-half of the nation's school districts provide students with access to at least one microcomputer or computer terminal, according to a recent survey of school districts conducted by the National Center for Education Statistics (NCES), U.S. Department of Education.*

The newly available low-cost mirocomputers, sometimes called personal computers, have created renewed interest in student use of computers in schools. Reportedly, school districts are providing students with access to these computers for a variety of learning and instructional purposes. However, no national information on the extent or nature of interactive use of computers by students has been available to assist planners among concerned public education authorities and among interested segments of the private sector. The NCES survey was intended to help fill this gap in planning information.

School districts make available almost 52,000 computers to students for educational purposes. This estimated total represents a mix of microcomputers and the more traditional terminals connected to a central processor.† In the short time they have been available for purchase, microcomputers have come to outnumber terminals, proportionately three to two.

More than twice as many districts provide microcomputers as terminals (Table 1). These districts put three-fourths of their available microcomputers, and a slightly smaller proportion of their terminals, to use at the secondary-school level.

Approximately one of every four public schools (about 22,000) currently has at least one microcomputer or computer terminal for instructional use by students. These schools represent one-half of all secondary schools, 14 percent of all elementary schools, and 19 percent of all other types of schools, such as vocational, special education, and combined elementary and secondary schools.

The most frequently reported educational use is to provide students with an understanding of computer concepts (computer literacy). Other major uses are to improve student learning in selected subject areas and to challenge high achievers. Less than half of the districts with computers use them for remedial and compensatory education. Most districts rely upon their computers for more than one of these educational purposes.

Computer availability within districts generally is limited, both in number of computers and location of computers (Table 2). Students in about three-fourths of the districts with microcomputers, and in similar proportion of those with terminals, have fewer than five computers available for their use. In the majority of districts having computers, only one elementary school and/or one secondary school has computer access.

About 18 percent of the districts that provide no current access plan to initiate student use of computers within three years. Most of these districts are small—fewer than 2,500 students. Potential growth in usage could be greater, however, since many districts reported that they were uncertain about future plans.

All districts in the survey reported on operational and planning needs considered critical to the initiation or expansion of the interactive use of computers. More than 40 percent identified each of two such needs: teacher training and a greater range of instructional computer programs. About one-third of the districts felt that assistance in planning an educational computer program and technical assistance in support of the program were needed. Additionally, almost one-third specified financial assistance as an "other" need.

The survey was requested by the U.S. Department of Education's Task Force on Educational Technology. It was conducted by NCES' contractor, Westat, a research firm in Rockville, Maryland, using NCES' Fast Response Survey System (FRSS). In late October 1980, questionnaires were sent to a national sample of 579 districts, representing the 15,834 districts in the nation. A response rate of 97 percent was achieved.

---

*School districts were requested to report only interactive use of computers, use that results in immediate computer response to direct student contact.

†Microcomputers were described in the survey as including a TV-like screen for display, a typewriter keyboard, logic and internal memory, some means of secondary storage for programs, and costing up to $5,000 each.

TABLE 1

PUBLIC SCHOOL DISTRICTS PROVIDING STUDENTS ACCESS TO AT LEAST ONE COMPUTER FOR EDUCATIONAL PURPOSES: UNITED STATES, 1980

		Type of School, by Grade Level			
Type of Access	Total (at Least One Level) (1)	Elementary Level (2)	Secondary Level (3)	Combined Elem/Sec Schools and Special Schools (4)	More Than One Level (5)
At least one microcomputer or one terminal	7,606	2,196	6,616	678	1,884
			(in percents of column 1)		
At least one microcomputer or one terminal	7,606	29	87	9	25
At least one microcomputer	6,631	29	84	9	22
At least one terminal	2,973	21	99	5	25
At least one microcomputer *and* one terminal	1,998	17	95	3	15

NOTE: Column 1 represents the unduplicated number of districts providing access to computers at any level. Since some districts make computers available at more than one type of school, the percents in columns 2–4 include duplicated counts of districts. The difference between the total duplicated counts (columns 2–4) and the unduplicated count (column 1) represents the percent of districts providing computer access at more than one level (column 5).

TABLE 2

AVAILABILITY OF COMPUTERS WITHIN DISTRICTS: UNITED STATES, FALL 1980

A. By No. of Computers per District

Number of Available Computers per District	Districts Providing Access	
	To Micro-Computers	To Terminals
At least one	6,631	2,973
	(in percents)	
At least one	100	100
One	40	35
2–4	37	37
5–10	13	14
11–20	6	6
More than 20	3	8

B. By No. of Schools with Access, per District

Number of Schools with Access per District	Districts Providing Access	
	At Elementary Schools	At Secondary Schools
At least one	2,196	6,616
	(in percents)	
At least one	100	100
One	56	68
2–4	24	25
5–10	13	6
11–20	4	*
More than 20	3	*

*Fewer than 1 percent.

NOTE: Percents may not sum to 100 because of rounding.

To obtain additional copies of this preliminary report, information about the survey or FRSS, or be placed on the mailing list to receive the forthcoming final report, contact the FRSS Project Officer, Jeanette Goor, National Center for Education Statistics, Room 620, Presidential Building, 6525 Belcrest Rd., Hyattsville, MD 20782.

School and Public Libraries Cooperate in a Grant to Provide Computer-Assisted Instruction

The San Bernardino Unified School District and the San Bernardino Public Library have received federal funds for a joint venture providing computer-assisted instruction for local students. Beginning June 1, 1982, the one-year project will make minicomputers available free of charge in three local public libraries. The primary purpose of the program is to assist students to practice their competencies in math and language skills in preparation for undergoing proficiency tests.

Ms. **Blake**. Thank you.

Therefore, we recommend part A, elementary and secondary assistance section 604, use of funds by local educational agencies, be amended to include inservice training for school librarians and media specialists as part of the instructional tool.

We recommend that the committee's report on the bill indicate that under section 604(a)(3)(4) may be used to acquire instructional materials and equipment. Such materials are particularly susceptible to rapid obsolescence. Spelling out such eligible uses will make clear the bill's support for informational technologies in the improvement of math and science education.

We also recommend that H.R. 30 be amended in part A to make clear that funds should supplement and not supplant local and State efforts.

In addition, local educational agencies should be required to maintain effort in order to be eligible for part A funds. Without such assurances, there is very real danger that Federal funds would simply be substituted for funds that would otherwise have been expended by State and local levels.

My testimony also includes the American Library Association comments and recommendations on the use of community resources such as libraries, in section 604(a)(5) of part A and postsecondary assistance in part B.

In deference to the time of this committee, this is just in the testimony.

I do want to thank Congressman Perkins, the cosponsors of the bill, the entire staff, for the development of a reasonable and workable approach to the crisis in mathematics and science education. We urge once more that you give particular attention to the critical role that librarian information services play in the improvement of mathematics and science education at every level. The full extent of the resolution is attached, together with suggested wording for amendments.

Thank you again for this opportunity to testify in support of H.R. 30.

Mr. **Kogovsek**. Thank you, Ms. Blake, for your testimony.

[Prepared statement of Helen Blake follows:]

PREPARED STATEMENT OF DOROTHY M. BLAKE

My name is Dorothy W. Blake. I am Coordinator of Planning for Media Resources and Utilization for the Atlanta Public Schools. I am President of the American Association of School Librarians, a major division of the American Library Association. I appreciate the opportunity to testify in support of HR 30, the Emergency Mathematics and Science Education Act, on behalf of the American Library Association, a nonprofit educational organization of almost 40,000 librarians, school library media specialists, library trustees and public-spirited citizens dedicated to the development of library and information service for all the American people.

At its Midwinter Meeting in San Antonio, the ALA Council passed a resolution which is attached to my testimony, encouraging Congress to "give particular attention to the critical role that library and information services play in the improvement of mathematics and science education at every level," in considering HR 30. ALA and AASL support the bill as a flexible vehicle for responding to congressional concern about mathematics, science, and technological education. We have some suggestions to improve the bill's response to the "explosive developments in electronic information technologies" noted by the Office of Technology Assessment in its September 1982 report, "Informational Technology and Its Impact on American Education" (GPO stock no. 052-003-00888-2).

Part A - Elementary and Secondary Assistance. We agree with the emphasis in the OTA report on the importance of information technologies -- their growing use throughout society, their significant promise as a mechanism for responding to the education and training needs of society, and their growing importance to the economy. The information revolution, according to OTA, is "creating new stresses on many societal institutions, particularly those such as public schools and libraries that traditionally have borne the major responsibility for providing education and other public information services."

Improvement of scientific and technological education cannot take place without supportive library resources that are up-to-date both in form and content. Not only must library resources be current with the latest developments and advances, but they must be available in the most useful and appropriate technological format.

Elementary and secondary school students as well as their teachers must learn to use newer technologies, such as microcomputers and/or computer terminals not only to solve mathematics and science problems, but to gain access to information needed for their education, and later for their work and for daily living. Much needed information, whether by access to the literature of a specific subject field or in community information resource files, will increasingly and often exclusively be available online rather than in printed form. School librarians and media specialists need training to evaluate and select such resources and equipment for schools and libraries, and training to assist students and teachers in the use of such resources. Computers are needed in the library as well as the classroom. Just as the library or learning resource center is the central location for materials in both print and nonprint format, it is the logical location for computer software and the accompanying hardware as well as access to online databases.

Therefore, we recommend that Part A, Elementary and Secondary Assistance, Section 604, Use of Funds by Local Educational Agencies, be amended to include inservice training for school librarians and media specialists, as part of the institutional team. We recommend that the Committee's report on the bill indicate that under Section 604 (A)(3)(4), funds may be used to acquire instructional materials and equipment. Such materials are particularly susceptible to rapid obsolescence. Spelling out such eligible uses will make clear the bill's support for informational technologies in the improvement of mathematics and science education.

We also recommend that HR 30 be amended in Part A to make clear that funds should supplement and not supplant local and state efforts. In addition, local educational agencies should be required to maintain effort in order to be eligible for Part A funds. Without such assurances, there is a very real danger that the federal funds would simply be substituted for funds that would otherwise have been expended at the local or state levels.

My testimony also includes American Library Association comments and recommendations on the use of community resources such as libraries (Section 604(a)(5) of Part A) and on postsecondary assistance (Part B).

Part A. Section 604(a)(5) - Use of Community Resources Such as Libraries. Under elementary and secondary assistance in Part A we are very pleased to see in Section 604(a)(5) under eligible uses of funds by local educational agencies a recognition of the importance of community resources such as libraries. We recommend that in the Committee's report on HR 30 a few illustrative examples of such use of community resources be included.

There are many useful possibilities of school system cooperation with public or academic libraries to achieve the purposes of the bill. For instance, in some communities, the local public library or community college or university library may have computer terminals for searching online databases not yet available in the schools. Cooperation could begin by providing the opportunity for advanced students and gifted classes to visit the library, learn the use of the computer, and search the literature of various scientific fields for special assignments, with federal funds subsidizing connect time and staff assistance. Cooperation could progress to the development of computer programs for instruction in the use of libraries, and to online "pathfinders" to suggested resources for an assigned topic in a high school science class.

In some small communities, perhaps no one library -- neither the school library, the public library nor the community college library -- could afford computerized databases, but through cooperation and modest federal assistance all local students and residents could have access to search terminals in one location. Schools which did have microcomputers could loan them to public libraries in the summer so that students could continue their progress. Federal funds might provide for connect time, maintenance, or teacher-taught courses in computer use.

If the microcomputers in school, public and academic libraries were interconnected, additional possibilities could be explored. Cooperatively, librarians might identify and coordinate an online catalog of audiovisual resources in the community, not just in schools and libraries, but also in business, industry, and organizations. Similarly an online listing of resources and equipment in science and technology available to faculty and students for special projects might be identified. An electronic mailbox for science students and their mentors in business and industry could be set up, as well as an electronic bulletin board for science education activities in the community.

Databases in the public domain could be identified with an eye to their instructional application in the schools. For instance, many public libraries have developed community information and referral databases with information on government and social services, organizations, etc. Although the protocols for searching each computerized database are different, the principles are similar. Such community databases, if accessible in the schools, could be used to teach the principles of online searching without the fees associated with commercial databases.

Another example of productive use of community resources is now in the planning stages in Fridley, Minnesota. The Anoka County Public Library System operates one of the local cable television channels. Each member of the local programming committee, composed of representatives from the public library, the city government, the local cable company, and the other local public access channel, plans to take a group of high school students and work with them on a cable TV program. The students would learn the electronics of cable television, as well as a great deal of other technological information through researching, writing, directing and producing their programs.

Because of the tight budgets under which almost all libraries are currently operating, cooperative projects such as these will develop slowly if at all. Yet it would take only modest aid for administrative support and telecommunications costs to make much more effective use of the informational resources which already exist in most communities and which can be used to support scientific and technological education.

Part B - Postsecondary Assistance. It is not possible to improve postsecondary education in mathematics, science, and technological subjects without up-to-date information resources and trained library and information professionals. This is particularly true because of the continuing information revolution in scientific and technological literature. There has been an explosion in the number of scholarly journal articles in the sciences. The number of references is so large and the need to keep up with recent developments so intense that the only feasible way to gain access to the journal literature of many specialized fields is through computerized databases. Through online searching, only those bibliographic citations which are pertinent can be brought up on a screen or printed out, sometimes with summaries or abstracts of the articles.

However, the latest developments in computerized databases are nonbibliographic databases. That is, they do not provide citations to other literature, but the actual scientific data or information needed for reference, research and development, or student problem solving. Chemical Abstracts Service in Columbus, Ohio, which has for many years produced indexes, abstracts and databases to chemical literature, now offers CAS Online which will eventually be a series of nonbibliographic databases. The first CAS Online offering is a registry of almost six million chemical compounds, which is accessible by registry number, full compound name, synonym, the elements in the compound, and how they are structured or the molecular formula. CAS Online costs $35 per hour plus a $10 telecommunications charge; there may be other charges depending upon the results desired.

Another nonbibliographic database in chemistry has been developed by a professor at Carnegie-Mellon University in Pittsburgh. CMU allows its archive of quantum chemistry, which provides data on different properties of chemicals, to be accessed by other chemistry departments at universities across the country. A major scientific publisher, John Wiley & Sons in New York City, has just announced their 1982 registry of mass spectral data, providing access to 73,000 spectra of 62,000 different compounds. This database is available online, or by purchasing the computer tape for $4,000 from Wiley and loading it into a local computer or spectrometer.

These are a few examples of the kinds of data and information that are just as necessary to science education and scientific research in universities as state-of-the-art lab equipment. As a matter of fact, the academic laboratory of the future may include a few terminals for database searching, or students may connect their own microcomputers to online databases. This would require that both faculty and students receive training from science librarians in the choices and protocols of retrieving information via electronic means.

However, there is as great a shortage of librarians with science or computer backgrounds as there is of science teachers. It is the area of librarianship where recruitment is most difficult, and for much the same reason -- salaries are higher in the private sector than in teaching or librarianship. The OTA report cited earlier notes the shortage of information professionals trained in the newer technologies.

One realistic approach would be to train library and information professionals with the requisite communication skills and an open approach to science to work with scientists. For this reason, ALA recommends that support for summer institutes under Section 623 be amended to include institutes and workshops for science librarians.

ALA also recommends that Section 625, upgrading laboratory equipment and facilities, be expanded to include improving the provision of scientific information and library resources to science faculty and students. We support Section 624, strengthening educational research and development, and suggest that the Committee's report on HR 30 make clear that research in science information for educational purposes may be eligible. The field is ripe for experimentation and model projects, including development of software packages to simplify computerized database searching.

We also point out that Part C authorizes not more than $50 million for postsecondary assistance under Part B however, only two of the five sections of Part B have specific authorizations, and those total $60 million ($10 million for Section 624 for research and development, and $50 million for Section 625 for lab equipment). We recommend that each section in Part B have a specific authorization, and that the total in Part C be adjusted accordingly.

Conclusion. President Reagan in his State of the Union message January 25 proposed a "quality education initiative to encourage a substantial upgrading of math and science instruction through block grants to the states." While block grants have usually been a means to cut support rather than to provide new funding, it is at least reassuring that the Administration recognizes federal assistance is required to meet this educational crisis.

We compliment Rep. Perkins, the cosponsors of the bill and the staff, for the development of a reasonable and workable approach to the crisis in mathematics and science education. We urge once more that you "give particular attention to the critical role that library and information services play in the improvement of mathematics and science education at every level," in the words of the ALA resolution. The full text of the resolution is attached, together with suggested wording for the amendments ALA recommends.

Thank you for this opportunity to testify in support of HR 30.

RESOLUTION ON THE EMERGENCY MATHEMATICS AND SCIENCE EDUCATION ACT

WHEREAS, Rep. Carl Perkins, Chairman of the House Education and Labor Committee, has, with numerous cosponsors, introduced HR 30, the Emergency Mathematics and Science Education Act; and

WHEREAS, HR 30 recognizes that library and information services are an essential component in the improvement of elementary, secondary, and postsecondary education in mathematics and science; and

WHEREAS, HR 30 further affords opportunity for cooperation involving public libraries and related institutions; now, therefore, be it

RESOLVED, that the American Library Association encourage that appropriate committees of Congress in their consideration of HR 30 give particular attention to the critical role that library and information services play in the improvement of mathematics and science education at every level.

Adopted by the Council of the
American Library Association
San Antonio, Texas
January 12, 1983
(Council Document #11.2)

HR 30, the Emergency Mathematics and Science Education Act

Amendments Recommended by American Library Association

Part A, Elementary and Secondary Assistance

Use of Funds by Local Educational Agencies

Section 604(a)(1)(A) inservice teacher training for recertification in mathematics and science, for computer competency, and for upgrading and modernizing mathematics and science knowledge, and (B) inservice training for administrative personnel, for school library media specialists, and for members of local boards of education;

Part B, Postsecondary Assistance

Summer Institutes

Section 623. From the funds available for this section for fiscal year 1984 or 1985, the Secretary of Education shall make grants to institutions of higher education to support summer institutes and workshops for teachers and supervisors of mathematics and science programs and for science librarians. Such institutes may also be conducted in such other areas of national need, as determined by the Secretary of Education.

Upgrading Laboratory Equipment and Facilities

Section 625. (a) The Congress finds that (1) the outmoded condition of instructional equipment, and research, library and laboratory facilities is a principal component in the current crisis in mathematics and science education, (2) the absence of state-of-the-art equipment, [and] facilities and information services has both immediate consequences...

Section 625. (b) The Secretary of Education, from the funds available for this section, shall make challenge grants available to provide not more than one-third of the cost of--

(1) the purchase of modern scientific equipment for use in teaching and research;
(2) programs to train faculty in the use of new laboratory and research equipment; [and]
(3) programs to improve the provision of scientific information and library resources to science faculty and students; and
(4) sharing scientific and engineering equipment among academic and business laboratories and research centers.

Other Recommendations

Part A - insert language similar to that in other education statutes requiring that funds supplement and not supplant local and state funds, and that maintenance of effort be required.

Part B - provide a specific authorization for each section and adjust the total authorization in Part C accordingly.

Mr. **Kogovsek.** We will hear from Dr. James Greeno.

You are representing the American Education Research Association. Please proceed.

STATEMENT OF JAMES G. GREENO, PROFESSOR OF PSYCHOLOGY, LEARNING RESEARCH & DEVELOPMENT CENTER, UNIVERSITY OF PITTSBURGH, REPRESENTING THE AMERICAN EDUCATION RESEARCH ASSOCIATION

Dr. **Greeno.** Thank you very much.

Mr. Chairman, I appreciate the opportunity to present testimony concerning needs and opportunities for research that can contribute to a solution of the nation's problems in education in mathematics and science on behalf of the American Educational Research Association.

I would like to present a brief summary of a few points from the written testimony that has been submitted. I am speaking especially in support of inclusion in H.R. 30 of a provision for support of educational research and development. We are pleased that a provision calling for such support has been included in the bill that is before the subcommittee. That seems especially important to us this morning.

Now that it is 12 o'clock, if the Secretary were here he might report in detail about the plans for the budget at the National Institute of Education next year.

We understand that they are calling for substantial reductions and in fact some rescissions for 1983.

Mr. **Kogovsek.** Doctor, we have had a chance to take a preliminary look at the budget. I think probably the Secretary is happy he is not here right now.

Dr. **Greeno.** It makes a provision such as section 624, I believe it is, especially critical for us.

Our problems with mathematics and science education are complicated and severe, as you well know. They involve shortages of several kinds, including shortags of qualified teachers and up-to-date resources for use in instruction.

One shortage that we can address effectively in research is a shortage of knowledge about how children learn mathematical and scientific skills and principles. With our present methods of instruction, as has been pointed out by others here, our math and science education is a highly selective enterprise. At each level of study many students drop out of the system and do not go on to further study in these fields.

There is a clear national need for a larger proportion of students to succeed in math and science instruction and research has shown that many of the students who do not continue very far have adequate basic cognitive skills to succeed in more advanced learning.

The results of recent research have clarified many aspects of thinking in problem-solving skills that students must acquire in order to succeed in their instruction, and in use of their knowledge of math and science in solving problems, both in school and in jobs that require technical training.

These results provide a basis for improved educational practice that could be developed now. There also are some important unanswered questions that require further investigation. We are on some exciting thresholds in research that have promise of providing further new insights of a fundamental nature into processes of thinking and learning, especially in mathematics and science.

I will just make one brief final point to close these brief remarks.

In the past, efforts to improve instruction in mathematics and science have either focused on the subject matter, ignoring learning processes, or have emphasized psychological processes without attending sufficiently to the subject matter.

Recently scientific developments have strengthened our ability to analyze processes of learning and understanding of subject matter contents in an integrated way. and I feel this provides an opportunity to obtain scientific advances that are of particular utility for education.

Thank you, Mr. Chairman.

[Prepared statement of Dr. James Greeno follows:]

PREPARED STATEMENT OF JAMES G. GREENO, UNIVERSITY PROFESSOR, UNIVERSITY OF PITTSBURGH, ON BEHALF OF AMERICAN EDUCATIONAL RESEARCH ASSOCIATION

Mr. Chairman, I am James Greeno,* University Professor of Psychology and Research Associate at the Learning Research and Development Center, University of Pittsburgh. I want to thank you for inviting me to appear today on behalf of the American Educational Research Association. I am presenting the Association's views on H.R.30 and the critical need for research authorities associated with new legislation in mathematics, science, and technology education.

My own research is focused on human thinking and learning associated with educational achievement and I would be glad to respond to questions from the Committee on significant research findings and promising current research topics related to teaching and learning in mathematics and the sciences.

First, There is little need to reiterate the studies and research which have defined and clarified the various issues and problems associated with learning in math and science. Hearings on this bill and prior testimony on similar legislation -- by the National Institute of Education, the National Academy of Sciences, the National Science Board, the Office of Technology Assessment, and various informed witnesses-- have identified the central issue and priority education problems associated with math, science, and technical literacy. Briefly stated:

> The intellectual demands of the workplace and advanced education require much broader student participation and success in mathematics, the sciences, and the higher order academic skills -- reading comprehension, problem solving, written composition, creative and analytical thinking, and technological literacy.

---

* Professor Greeno is also the President of the Federation of Behavioral, Psychological and Cognitive Sciences.

Yet, as Michael Kirst recently summarized:

> "...we find ourselves in a vicious cycle of teacher shortages, outmoded curricula, and unmotivated students." ("Improving Math, Science and Technical Education" California Commission on Industrial Innovation, July 1982)

The resarch and testimony focus on the following priority problems:

> 1. Out-of-field and out-of-date teaching force. Many teachers are in math and science classrooms, particularly in secondary schools, who are not prepared to teach the courses they are assigned. They serve with "emergency certificates" or have little recent information on math, science, technology, and instructional advances.
>
> 2. Severe shortages of qualified math and science teachers due to an inability to attract new teachers to the classrooms or to the inability to keep able and effective teachers.
>
> 3. The need for more effective and motivating teaching resource materials and teacher training resources so that we can reach a larger number of students. Due to dramatic cuts in educational research and development, dissemination and technical assistance, the capacity to improve student motivation and learning and to adequately prepare and update teachers in mathematics and science has declined.
>
> 4. The need for greater access and more effective use of instructional technologies. The micro-computer and other information technologies are unevenly distributed in education institutions, they are under-used for instructional purposes, and the software materials are not adequately developed with an understanding of the latest research on student learning and instruction.

With few exceptions, research and the reports on the problems and issues call for a sustained program of educational research as an essential resource for other federal, state, local and institutional programs to improve mathematics, science and technical education. The following educational research efforts should be seen as priorities in new math and science education legislation--

> (a) research on thinking, teaching, and learning related to instruction in math, science and technology, including reasons for learning difficulties and the instructional uses of information technologies;
>
> (b) the application of research findings to the development of instructional resource materials and teacher training programs;
>
> (c) research on the effects of secondary school organization and instructional strategies on student learning in math, science and technology;

(d) research on student achievement in higher order academic skills -- reading comprehension, written composition, problem solving and creative, analytical thinking, including computer and technological literacy-- which are essential for work and further learning;

(e) analysis of local and institutional policies enhancing or inhibiting the recruitment, retention, and upgrading of mathematics and science faculties.

WE WANT TO PRAISE THE ACTIONS OF THE BIPARTISAN COSPONSORS OF H.R.30 FOR INCLUDING A PROVISION FOR SUPPORT OF EDUCATIONAL RESEARCH AND DEVELOPMENT. This essential section of the bill will provide the needed authority to revitalize the National Institute of Education's research program focused on the critical issues facing math and science education.

For each of the priority problem areas outlined above, new research projects and efforts to use current findings of educational research will provide knowledge and informational resources that are needed for educational improvement. As will be outlined below, these studies will contribute to both short-term efforts to ease immediate problems and long-term fundamental solutions.

The Uses of Research Findings

Educational research has made important progress in identifying successful teaching practices, effective school characteristics, and student learning. Although the majority of these studies have been focused on elementary schools, progress has been made recently which will contribute instruction at the secondary education level, particularly in mathematics and science. There is significant need for further work in these areas; however, not all of what is known is effectively incorporated into instructional materials and teaching practices. For example, recent research on how children approach math and science problems is ripe for development into improved diagnosis and instruction.

The Promise of Emerging Research Finding & New Research Programs

Fortunately, past and current research efforts are, although poorly funded, on the right track. They allow us to build new research on past knowledge, to ask the right questions and, most importantly, to provide practical and useful information to those in the front lines of education --the teachers, administrators, and education policy makers.

The focus of research studies on mathematics and science instruction will help us blend the need to learn substantive knowledge with effective instructional strategies. In past efforts, either too much emphasis was placed on providing teachers with new mathematics and science information --to the neglect of realistic ways to assist students in real classroom situations-- or too much focus was placed on teaching process concerns --to the neglect of important substantive curricular needs. Recent improvements in research will allow the research authorized in H.R.30 to promote an appropriate mix of process and substance and their application to:

--instructional materials

--teacher training programs

--school-site instructional improvement

--secondary school math and science programs

--advances in technological literacy and the appropriate and effective instructional uses of information technologies.

These research and instructional improvement efforts need to be initiated NOW. The outmoded instruction and curricular materials and strategies demand upgrading. Our methods of teaching mathematics and science, successful for a small number of students pursuing academic careers in these areas, are not adequate for the much broader student population needing these academic skills.

The demands of work and essential academic skills, what employers call these "learning to learn" skills, require that we provide teachers with the best available knowledge and material resources.

In summary, I would like to outline the priority problem areas and indicate potential solution categories and the contributions of current or potential research findings.

Summary of Math and Science Education Problem Areas

(Possible solution categories and research and development contributions)

Note: These possible solutions have been identified from proposed legislation, state and local efforts, and from testimony. They are not specific recommendations by AERA.

OUT-OF-DATE AND/OR OUT-OF-FIELD (UNQUALIFIED) MATH AND SCIENCE TEACHERS

Most immediate solution categories:

—individual continuing education for teachers already in service (substantive knowledge in subject areas and recent developments in teaching strategies);

—staff development at the school site (working to make the school and classroom effective places to teach and learn).

R&D Contributions

Immediate contributions of effective teaching and school research findings to teacher training programs are needed to mount inservice education programs and staff development efforts. Particular fields for research application include: math and science classroom management and instructional strategies, student thinking and learning, and initial identification of effective secondary school characteristics.

OUT-OF-DATE OR INEFFECTIVE TEACHING RESOURCES (materials/strategies) & TEACHER TRAINING PROGRAMS (for new teachers and those already teaching)

Solution categories:

—the improvement of teacher training and staff development programs (using available information on mathematics, science, and instruction/learning strategies);

--the development of curricular materials, including computer software;

--developing reward systems which bring together teachers and teaching resource organizations.

R&D Contributions

--the application of teaching and learning research to the development of texts, instructional software, and teacher-developed instructional programs.

—new R&D into student motivation, thinking and learning, and applied research on classroom teaching in mathematics, the sciences, and technical literacy.

—reasons for learning difficulties in M&S.

--the identification of essential academic skills needed for successful work and future learning (including on-the-job training).

THE LACK OF QUALIFIED TEACHERS ENTERING THE PROFESSION, AND THE LOSS OF CURRENT TEACHERS TO OTHER OCCUPATIONS.

Solution categories:

—teacher education incentives and support;

--status improvement of the existing teaching force;

—using qualified teachers in staff development efforts;

--providing financial rewards for entering and staying in math and science teaching.

R&D contributions

—analysis of local and institutional policies as they affect the recruitment, retention and professional advancement of teachers.

—comparative studies and dissemination of effective strategies for coping with the problems.

—collaborative research using qualified researchers as teacher-researcher partners with principal investigators on math and science education research projects.

LACK OF ACCESS AND EFFECTIVE INSTRUCTIONAL USE OF COMPUTERS AND OTHER INFORMATION TECHNOLOGIES

Solution categories:

—provide funds for the acquisition of micro-computers and other technologies

—provide incentives for corporations to provide schools with low cost or no cost equipment;

—provide support and incentives for educators and publishers/software developers to work together on the development of improved resource materials;

—provide support and incentives for schools to work with private and public sector math and science resources —museums, libraries, scientific laboratories, the media, and so on.

R&D Contributions

—the application of teaching and learning resarch to the development of texts and software.

—R&D into the effective uses of computers and instructional technologies in realistic classroom settings (for computer literacy and for instruction in mathematics and science).

--research to develop criteria for school boards, teachers, and administrators to assess the value of various types of instructional hardware and software.

--research on the effects of new technologies (both in and outside of schools) on student achievement in academic subjects.

I thank you for this opportunity to present the views of the research community. I will be pleased to answer any questions. The American Educational Research Association is most willing to work with the Committee to provide information resources which you request.

Mr. **Kogovsek**. Thank you, Doctor.

We appreciate the testimony of everybody on the panel.

I would like to at this time ask a couple of questions. I will have some general questions, but I would like to ask Ms. Kemble especially.

You had indicated in your testimony, Ms. Kemble, that we have to do a better job as far as teachers are concerned in the area of math and science. And you of course support legislation or whatever help you can get to do a better job in the public school system than we are doing, as far as emphasizing the job that has to be done in this area, to the point where you are willing to spend some extra money. Would you have any problem as far as other areas of education are concerned, as far as AFT?

In other words, all of a sudden you have teachers in other areas of education, whether it is history or whether it is whatever, coming to you and saying, "You are up there testifying on this piece of legislation, pushing hard—what are you going to do for us?"

Ms. **Kemble**. That is a very good question. We just had an extensive debate about this very topic at our council meeting last week.

I think that we are concerned that some of the electives—and obviously "electives" is a broad term, and it includes academic as well as other kinds of subjects—have been soft electives in the past and we would like schools and districts to take a very close look at what really is essential.

I would like to make clear we are still debating this point, that we will be interested in looking at the possibility of more flexible scheduling within schools if that becomes necessary. But it is something which our national organization is not going to come out with some sort of a standard view on.

Obviously, if you end up saying that you are for more mandated academic subjects and the school day is only so long, something may have to go, or it may be that you end up with an extended day for students. I emphasize "students." But there may be some need to look at flexible arrangements at the local level.

Mr. **Kogovsek**. You indicated in your testimony there were four problems, and I think you list them pretty much in order.

One, test scores are down; two, curriculum requirements are low; number three, students are losing interest in the area of science and math; four, there is a teacher shortage.

Let me just ask you and anybody else on the panel, I think we would be interested in any suggestions you might have for alleviating, first of all, the teacher shortages in the areas of science and mathematics. Pay of course is what it is all about.

Does anybody want to comment on that? How can we attract good teachers and keep good teachers when teacher salaries are stagnating due to budget cutbacks on the Federal level and on the State level and on the local level and especially, as has come out, the other industries are paying higher salaries.

Ms. **Kemble**. Well, it is a difficult question.

I think obviously, as I have indicated, salaries have to be higher. I would also like to say that—and this is not really a Federal matter—the kinds of proposals that we have seen by way of salary differentials for specific areas are not anything that we think is going to solve the problem.

First of all, they are being proposed in amounts that are really not sufficient to make teaching competitive with private industry. Obviously you are going to have to have massive salary increases in order for teaching to be competitive.

I think for people who are on the job, and we find that people who are in these specialty areas—math, physics, chemistry, right now—do tend to be older teachers. We have to address the question of how to keep them there, so they don't go into the private sector.

Now, you get to some long-term issues. They are not short easy solutions.

If you take the elementary issue, which I raised earlier, one of the problems with teachers is they are getting a lot of disinterested students who don't want to be in courses and part of this happens because the students themselves are insecure about the subjects and we simply—a long-term issue, like it or not, is what happens to these kids at the elementary level?

There is a question of working conditions for teachers, how many courses they have to teach, how many kids in their classrooms. There is just no easy way to narrow the focus of these kinds of solutions.

I think you are getting what you think is a predicted answer, but it is also a valid one. There is just no way around it.

Mr. KOGOVSEK. I do expect that answer, and it is the answer that is accurate, as far as I am concerned. It is not an answer that you can come up with in 30 seconds and solve in 1 year's budget and all of a sudden in 1984 things have turned around.

Ms. KEMBLE. Can I just say one thing about the Secretary's merit pay proposal, because I think that that is something that looks on the surface to have some appeal.

From our experience with teachers, this could have just as much an effect to push people out of the profession—as a matter of fact, more than he thinks it will have an effect to keep people in.

Our experience with these kinds of schemes is that the ways in which these determinations will be made will be largely political within the school itself. Teachers would not be picked on the basis of merit. Where these have been tried before, it is because they are willing to give up sick days or take on extra administrative assignments. It is not because they are really the best teachers. If you had a system whereby merit was really the overriding factor for selecting a few people who would maybe do a distinctively different job, that would be one thing, and our unions have advocated that in some local places. But that is not what is being proposed.

What could happen is, people get these jobs and people who don't get them being very discouraged and feeling why should they stay in teaching anyway.

Mr. KOGOVSEK. Let me ask Mr. Johnston, do you have any ideas about how we might attract more students to take more math and science courses. Should States and local educational agencies raise their curriculum requirements in these areas?

Mr. JOHNSTON. I think we have already taken a big step toward increasing the number of people going into math and science. The mere fact that we acknowledge the value of mathematics and science is going to make a big difference.

In Colorado, our Governor has made this a part of his State of the State message. Now, it is my understanding that it is being promoted in almost all States.

I really think that in my talks with parents that they are beginning to recognize that they need to play a bigger part in working cooperatively with their children in selecting courses. That is why I said earlier that I think this $250 to $300 million is going to have a far greater impact than the mere dollar amount. It is going to be publicized, people are going to take another hard look at it, recognize the need for it.

I think I can assure you in the schools I am familiar with there is going to be a much, much bigger interest in science and math. I also think that is going to help get teachers back into the math and science teaching.

You know, the public perception of teachers is not really all that great all the time, but something like this puts added emphasis on the value that teachers have. You are going to see some real improvements.

Mr. KOGOVSEK. Thank you.

One last question, before we get to the gentleman from Pennsylvania, to Dr. Greeno.

Do you have any ideas, Doctor, about how we might attract more students to take math and science courses? And before you answer that—it was suggested by somebody on the panel that the Federal Government should help as far as the curriculum is concerned, without writing the curriculum. Should States and local agencies raise their curriculum requirements in these areas?

Dr. GREENO. Well, let me speak to the first question.

There has been a considerable amount of study recently of the kinds of factors that influence students when they are making choices whether to continue their study in science or mathematics, and the results emphasize a point that came up in earlier discussions and questions from the committee—the close relationship between what happens to youngsters in their elementary training and what they are likely to do when they get to high school.

It is clear in the first place that getting an adequate background is critical, of course. But also, the kinds of experiences that students have when they are beginning to study mathematics and science go a long way to influence their own attitudes and their interests in continuing in their field, their own perceptions of themselves as to their own capabilities for whether they would do well in those courses. There is much that we still need to learn about that. But I think there are some pretty clear implications for what can be done in the elementary level that would have substantial effects on this.

Mr. KOGOVSEK. Thank you, Doctor.

The gentleman from Pennsylvania, Mr. Murphy.

Mr. MURPHY. Thank you, Mr. Chairman.

I, too, add my thanks to the panel for their thorough review of H.R. 30. I would like to ask the members of the panel have they also examined H.R. 582, which is Mr. Fuqua's bill over in Science and Technology, which deals with the same thing.

Have you had an opportunity to review that measure? Dr. Greeno.

Dr. **Greeno**. I was able to review it. It is in preliminary form, I believe.

Mr. **Murphy**. I might advise the rest of the panel to take a look at that. I think we might run into a policy decision here as to where to place our limited resources. Whether it should be on the postsecondary level to keep and retain the teachers of teachers or whether we should encourage from the elementary level on up more people to enter into the math and science fields and obviously increase the volume of teachers of teachers eventually.

You may want to look at that. I agree with the panel's comments, I think you are all of the same opinion, especially the same man and I, that this money, if we have it, should not be used to replace local efforts or to be used to encourage, as Ms. Kemble points out, the paying of teachers to serve on lunch duty or cafeteria or proctoring or something else, that we should put it to actual good use.

May I ask, as we try to attract more students into the math and sciences, one, of course, is financial incentives which are always a great aspect of it. Do you think if we offered the colleges extra subsidies for the credits that they offer in math and science, if you sign up for math I or algebra II or calculus, that we would offer to the colleges an additional subsidy for the teaching of those, and thus encourage the student who is looking for a break in his tuition: Gee, I might as well load up on math because I can get that cheaper per credit than I can in political science.

Do you think that would help? It is a direct subsidy where it would actually be used, it wouldn't be prostituted with something else. What do you think?

Ms. **Kemble**. A form of scholarship, right?

Mr. **Murphy**. Right, a limited scholarship toward math and science.

Dr. **Greeno**. It would certainly provoke lively discussion in the faculties.

Mr. **Murphy**. How about another subsidy then to offer out to the States a bonus payment to math and science teaching? Once we put the money into the Reagan-type block grant that can go back to the States and school districts to be used for whatever purpose they choose, with only limited guidelines, and it will be pretty well lost as it trickles down I would think.

Ms. **Kemble**. If what you are talking about is a differential only in those areas, a salary differential for those teachers——

Mr. **Murphy**. Yes.

Ms. **Kemble**. We would be opposed to that and we don't think it would work. It is not just because our people don't like it.

First of all, you would have an incentive for teachers to shift districts, unless it were done across the board and it wouldn't be. It would be done differentially. That means you pull teachers from one district and put them into another, and that would only create chaos and doesn't solve the shortage problems.

If what you want to do is get new people, it is the lower end of the scale that you want to up. You need to go that across the board.

Mr. Murphy. Can we do that and gear it towards math and science. It is not the Congress' responsibility to judge the misassignment of teachers or the specific reeducation of misassigned teachers. She used to teach geography but the only class available now is math and she took math I in her first year of college, so they switch her over.

That is something we cannot guide here. The local school districts have that responsibility.

Ms. Kemble. While it is not in this legislation, I understand the differential idea, at least having it as an allowable item, has come up in consideration of other legislation to be drafted. So it is relevant to make the point.

Mr. Millenson. Mr. Murphy, I would like to comment on your previous question if I may where you asked about views on H.R. 582. That is the Fuqua bill now in the Science and Technology Committee.

Section 4(a) of that bill says the NSF is authorized to spend money for grants for such research, fellowship, capital equipment, salaries, instrumentations and other activities as are considered necessary in carrying out the purpose of this act.

I would like to direct your attention to two items with respect to that. Number one, in ESEA title X which deals with section 1001 in definitions, subsection D deals with the definition of the term "equipment." And in defining "equipment," that term has long included what is sometimes called software, instructional equipment, not just the hardware.

It includes printed and audio-visual materials.

I think that any legislation, language similar to what they have here in section 4 of the Fuqua bill should be considered.

Two, in previous testimony before this committee, the experience with ESEA which was then title II of how closets were filled with unused equipment was cited by a number of members of this committee and also by some witnesses. It is quite clear that if adequate complimentary software or instructional material, whatever you call it, is available, and is used, then the hardware will be used—will not end up in the closet.

We have to be very careful that any legislation enacted by the Congress to encourage use of new technology does not end up with having money spent for more closets.

Mr. Murphy. Thank you, I appreciate that.

Recently my Subcommittee on Select Education released a report entitled "Education Technology and Its Impact on American Education." Many of the issues you have raised here this morning were covered in that report. Because of all those issues and the ones you have raised this morning regarding teacher training, research needs and to vocational training needs, et cetera, do you think that we are trying to do too much in H.R. 30, taking into consideration that there may be a few of us who agree that there is not enough funding in the authorization.

But being realistic as to what we may come out with, do you think we are attempting to do too much in this particular legislation, that maybe we should reduce it or confine it to some limited usefulness?

Ms. Kemble. Yes, I think——

Mr. **Murphy**. If so, where should we place our limited resources?

Ms. **Kemble**. I agree with the Secretary's instincts that this problem needs focus. Where I disagree is that even in the focus that he outlines there is anywhere near the money required. I think the focus I have indicated is clear. I think retraining is the issue. It is immediate. It is large.

Mr. **Murphy**. Thank you.

Mr. **Bowen**. Mr. Murphy, I would agree that focus is important and relative to the recruitment of both teachers and students, I think one thing you are already doing through this legislation which will be very, very important is you are going to attract national attention, which is already growing about this problem.

That is paramount, I think, to teachers and to students because this will get the media coverage necessary to have it brought to their attention.

Second, I would encourage the focus out of which would emerge good demonstrations that would not only impact math and science education, but impact other areas of education.

If we find ways in math and science to use the new technologies to expand our gifted teachers through outreach and to enhance their jobs, which I think is important to recruiting new teachers and to getting students into course areas, I think you will have vast impact.

Unfortunately, we will be splitting this up, I think, a little to inservice, a little to new technology, a little to some grants, et cetera, and in the end it would be watered down. I would encourage focusing in key areas and three have been mentioned here by almost everyone on the panel.

Dr. **Greeno**. I would like to express my anxiety a bit.

If the bill were to become focused on this in a clear way, I would expect the major attention would be given relatively short run or immediate problems which is necessary, but I will express the hope simply that the committee would have a concern for some of the long-term concerns that would put us in place for making the best possible use of the kinds of technologies as we get more knowledge about these things.

There should probably be a component in there even if it doesn't clearly address the major concern.

Mr. **Kogovsek**. You wanted to comment, Ms. Kemble?

Ms. **Kemble**. Yes, the retraining emphasis will have an effect on curriculum. The Secretary is right, with the pressures to upgrade standards, State and local levels, how will they upgrade the standards if they don't have the people? If you give money for retraining you are giving them an incentive to upgrade standards, and they will have to put money in because they have to pay the people who get put on the job in those subjects.

Mr. **Kogovsek**. No two ways about it, the administration makes it difficult. We are going to find that out. I think we all agree this is an important piece of legislation.

The Secretary indicated it is an important area we have to focus our attention on, both financially, morally and so on; yet it will be difficult for us as we move this legislation through to convince everybody, Democrats and Republicans alike, that we should spend this money in this area when the administration will recommend cutbacks.

You will see those as the budget becomes more clear, significant cutbacks in vocational, bilingual, significant cutbacks as far as Indian Education Act, and we are back to the age-old problem where we cut or add, and that is the discussion that will be in front of this committee.

I would once again like to thank the members of this panel for being here this morning.

Before we adjourn, we have with us Ms. Alice McDonald, who is the deputy superintendent of public instruction for the Kentucky Department of Education. It is my understanding that your plane was delayed getting in from Lexington, and we would like to hear from you at this time, Ms. McDonald.

STATEMENT OF ALICE McDONALD, DEPUTY SUPERINTENDENT OF PUBLIC INSTRUCTION, KENTUCKY DEPARTMENT OF EDUCATION

Ms. McDONALD. Thank you very much.

Mr. KOGOVSEK. The chairman was called to the White House, I am not sure you were aware of that, and he has not yet returned. In the meantime, I am taking his place and we would like to hear your testimony at this point.

We have put time constraints on everyone, we have tried to get their testimony in 5 minutes. It is hard to present your testimony in 5 minutes, I know, on an important subject like this, but if you would keep that in mind.

Ms. McDONALD. Thank you very much. I am glad to be here in your presence, even though the chairman had to leave.

I had intended to be with Mr. Barber this morning, but U.S. Air had other plans. I will provide the written testimony to you, and briefly summarize now—when I get it duplicated or when U.S. Air locates my luggage.

Mr. KOGOVSEK. Without objection we will keep the record open until it gets here.

Ms. McDONALD. It will be a very brief summary.

I am here to address you today in support of the proposed Emergency Mathematics and Science Education Act. Today there is widespread agreement nationally that we are fast approaching a crisis situation.

Kentucky recognized an impending educational crisis in the Commonwealth due to the shortage of mathematics and science teachers. As a result, in the past year Kentucky created a scholarship loan program for college students.

We believe that while our scholarship loan program is a move in the right direction for math and science teachers, we are only scratching the surface.

However, the teacher shortage is a nationwide problem. The National Science Commission on precollege education in math, science, and technology, released a report which included these statistics. They reported a shortage of math teachers, and physics teachers; inadequate or in some cases nonexistent equipment in the math and science fields.

The fact that the proposed Emergency Math and Science Education Act strongly addresses this contributing problem is a further reason this bill is an essential piece of legislation. The central theme of this entire issue is the student himself. It has been documented that student achievement in math and science is declining as evidenced by declines in both science and math achievement scores; declines in students prepared for postsecondary studies are also apparent.

The Commission report also revealed that as many as one-third of our secondary schools do not offer sufficient math courses to qualify their graduates for admission to accredited engineering schools.

As difficult as it is to accept, the fact exists that our United States educational system has actually regressed in that the proportion of students in grades 9 to 12 enrolled in science and math courses as compared to total enrollment has declined in the past 20 years.

In this area our schools were more effective 20 years ago than they are today.

Another area which has the potential to exert a negative effect on both the quality of instruction and the levels of achievement in math and science is that of inadequate educational research in math and science education.

Although considerable progress is being made in these areas, the need still far outweighs present and past accomplishments in this area. The proposed Emergency Mathematics and Science Education Act before you also addresses this all important aspect of the problem and is another reason I feel it is a strong and essential measure.

In closing, I would like to say to members of this committee that the Educational Foundation of the United States desperately needs the provisions proposed by the bill. The proposed act would not only provide a skilled work force for our highly technological society in general, but would provide a skilled work force for a quality technologically complex defense system.

Finally, I sincerely feel that the proposed act would stimulate the transition of our Nation from an industrial to a highly technological society. Once again, I would like to thank the members of this committee for allowing me to speak in support of this matter.

Thank you very much. If you have any questions, I would be glad to answer them.

[Prepared statement of Alice McDonald follows:]

Prepared Statement of Alice McDonald, Deputy Superintendent of Public Instruction, Kentucky Department of Education

Congressman Perkins, and members of this distinguished Committee, I am Alice McDonald, with the Department of Education, State of Kentucky. I sincerely appreciate the opportunity to appear before you to sepak concerning a matter of national importance.

I wish to address you today in support of the proposed "Emergency Mathematics and Science Education Act." Today there is widespread agreement nationally that we are fast approaching a crisis situation not unlike that the United States faced when the Soviets launched Sputnik in 1957. Specifically, I am referring to the enormous difficulties we as a nation face in trying to meet the needs of this country in our rapidly changing society—a society that daily sees our nation become more and more dependent upon sophisticated technology. The trend is moving toward a continually increasing number of citizens growing up lacking the understanding and skills needed to function in our modern technological world. The only means by which our nation's political and educational leaders can counter this trend is to upgrade the quality of instruction and the levels of achievement in the areas of mathematics and science at both the elementary and secondary levels. To accomplish this goal it is necessary to increase the numbers and qualifications of teachers of mathematics and science at these levels. The proposed "Emergency Mathematics and Science Education Act" should be enacted, for it is aimed at both improving instruction and achievement levels in mathematics and science as well as alleviating the teacher shortage in these areas.

Kentucky recognized an impending educational crisis in the Commonwealth due to the shortage of mathematics an science teachers. The state has experienced a steady decline over the past ten years in the production of mathematics an science teachers. In 1971, 308 mathematics and science teachers were newly certified in kentucky as comparred to only 110 in 1981. Approximately 20 percent of the state's science classes are being taught by teachers who have neither a college major nor minor in science. In one area of the state, a survey showed that of 216 instructors teaching earth science only four were actually certified to teach the subject. Parallel to these statistics, between 10 and 15 percent of Kentucky's public school math classes are being taught by teachers out of their college fields. According to a study conducted by the National Council of Teachers of Mathematics, Kentucky has a critical shortabe of physics and math teachers as well as shortages of chemistry and earth science teachers.

As a result of that study, in the past year Kentucky created a scholarship-loan program for college students in their sophomore through senior years that provides grants of $2,500 a year to attract and retain qualified teachers in the math and science fields in grades 7–12. If the student enters teaching in the mathematics or science areas, a year of the loan is forgiven for each year the student works as a teacher. In the event the student does not teach, the full amount of the loan must be repaid at an interest rate or Treasury Bills plus 3 percent. The program is working very well with $200,000 already loaned to more than 100 students during the program's first year of existence. For the next year, $410,000 has been budgeted for the continuance of the current program and the addition of another 100 new students.

We believe that while our scholoarship-loan program is a move in the right direction, we are only scratching the surface. At least two other states and several local governments have instituted similar programs for locating and training more math and science teachers. However, the teacher shortage is a nationwide problem, according to Harry Tunis, research director of the National Council of Teachers of Mathematics. Tunis states that the Council's studies have shown that most states suffer from either "shortages" or "critical shortages" for high school teachers of biology, chemistry, physics, general science, earth science, and math.

The National Science Board Commission on Precollege Education in mathematics. Science, and Technology recently released a report which included some alarming statistics. This report revealed that in 1981, 43 states of 45 responding reported a shortage of mathematics teachers. Shortages for physics teachers were reported by 42 states. During the same year, 50 percent of the teachers newly employed nationwide to teach secondary science and mathematics were actually uncertified to teach those subjects. From 1971 to 1980, student teachers in science and mathematics decreased significantly—a third as many in science and only a fourth as many in math. Alarmingly, only one-half of this shrinking number actually entered the teaching profession. The Commission's report also disclosed that fully 25 percent of those now teaching math or science expect to leave the profession in the near future.

Inadequate or, in some cases, nonexistent equipment in the mathematics and science fields compounds the nationwide problem or improving instruction and increasing achievement in these areas. No matter how exceptional our teachers and students, they are sorely handicapped by outmoded instructional equipment. The fact that the proposed "Emergency Mathematics and Science Education Act" strongly addresses this contributing problem is a further reason this bill is an essential piece of legislation.

The central theme of this entire issue is the student himself. Why is there such alarm, almost to the point of panic, being raised over student levels of achievement in mathematics and science at the elementary and secondary levels? The answers may be derived from startling findings.

Previously I referred to a report released last October by the National Science Board Commission on Precollege Education in Mathematics, Science, and Technology. Let us look at some of the other frightening data disclosed by this study. It has been documented that student achievement in math and science is declining as evidenced by declines in both science and math achievement scores of United States 17-year olds in two areas: (1) declines in mathematics scores of 17-year olds, especially severe in the areas of problem-solving and applications of mathematics, and (2) declines in mathematical and verbal Scholastic Aptitude Test (SAT) scores of students over an 18-year period extending through 1980.

Declines in students prepared for post-secondary study are also apparent. Between 1975 and 1980 total student enrollment, at four-year colleges and universities increased by seven percent, but at the same time remedial mathematics enrollments increased by 72 percent. Nationwide at public four-year colleges, 25 percent of the math courses offered are remedial while at community colleges this number increases to 42 percent.

The Commission's report also revealed that as many as one-third of our secondary schools do not offer sufficient mathematics courses to qualify their graduates for admission to accredited engineering schools. Nationally only one-third of our high schools teach calculus and fewer than a third offer physics courses taught by qualified physics teachers. Many educators today are concerned by the overall state of our math and science instructional programs in this country. Not only are we concerned with those students desiring to enter careers in the mathematics and science fields, but we are equally concerned with those students who do not plan such careers. In 1980, only 9 percent of those students graduating from vocationally-oriented high schools took three years of science courses, and only 18 percent took three or more years of mathematics courses. As difficult as it is to accept, the fact exists that our United States educational system has actually regressed in that the proportion of students in grades 9 to 12 enrolled in science courses as compared to total enrollment has declined in the past 20 years. In this area our schools were more effective 20 years ago than they are today.

Another area which has the potential to exert a negative effect upon both the quality of instruction and the levels of achievement in mathematics and science is that of inadequate educational research in math and science education. Although considerable progress is being made in these areas, the need still far outweighs present and past accomoplishments in this area. If we do not continue to learn more about the learning process itself and how to reach students through effective instructional approaches in the classroom, everything else we do will be in vain. The proposed "Emergency Mathematics and Science Education Act" before you also addresses this all important aspect of the problem and is another reason I feel it is a strong and essential measure.

Educational leaders nationwide are in agreement that the existing shortages of mathematics and science teachers are fast approaching the critical stage. Efforts at the local and state levels might temporarily slow this slide toward disaster, but only the federal government has the ability and resources to solve the problem. Incentives, such as those contained in the proposed "Emergency Mathematics and Science Education Act," must ge given to teachers and prospective teachers in the math and science areas in order to convince them to stay in the schools. Something must be done to halt the staggering number of math and science teachers leaving education for more lucrative jobs in business and industry.

The Soviet Union's launching of an earth satellite in the 1950's convinced many Americans of a challenge that became a matter of public policy. The same challenge has again been directed to the United States by way of a recent, well-publicized comparison between the mathematics and science curricula of the two countries. Something must be done now to provide a vital dose of adrenalin to our nation's schools at a time when our needs in the mathematics and science areas are greater than ever before. If we do not take immediate action to bolster programs in these vital areas, how can we possibly claim to be serious about maintaining, or as some might say regaining, our nation's leadership position internationally in science and technology.

In closing I would like to say to the members of this distinguished Committee, the educational foundation of the United States desperately needs the provisions proposed by the "Emergency Mathematics and Science Education Act." To delay such action any longer could be disastrous. I urge you to act now and to pass this crucial piece of legislation. The original National Defense Education Act of 1958 was an historical document that reshaped and redirected education once before at a time when we faced a national crisis. The measure before us today would amend the National Defense Education Act by adding a new title and is equally as important and essential as was the original act. The proposed "Emergency Mathematics and Science Education Act" would not only provide a skilled workforce for our highly technical society in general but would provide a skilled workforce for an equally technologically complex defense system. Finally, I sincerely feel that the proposed "Emergency Mathematics and Science Education Act" would stimulate the transition of our nation from an industrial to a highly technological society.

Once again I would like to thank the members of this Committee for allowing me to speak in support of a matter of utmost urgency and importance to all of us in this great nation.

Mr. Kogovsek. Thank you for being here, Ms. McDonald.

As I indicated, your written testimony will be made a part of the record. The record will be kept open until we receive it.

As you know, and you have had a chance to listen briefly to some of the testimony that the previous panel gave us, we were talking about a large monumental problem here and a problem that will not be solved overnight.

Do you have any suggestions as to what do we do? We are in a situation here now—this is a small part of the problem—we have high school students who at least in this person's mind tend to not want to take some of the math that they should take, some of the advanced math they should take in their third or fourth year of high school just because their parents put emphasis on getting some kind of a straight A average, and consequently they know one way to do that is not to take more difficult courses like math and science.

What do you do as an educator, as a superintendent, to solve a problem like that?

Ms. McDonald. I think educators need to take some responsibility on the local level and the standards need to be there. In Kentucky in the last few months we have started a new college prep program. In order to enter college you must have 20 credits instead of the 18 now, and the extra 2 credits would be math and science.

If you graduate with 18 you can enter college conditionally and in the years to come we look for several of the colleges not to take students conditionally.

I think we are over a period of time forcing our students back into college preparatory courses so they do not take them on a remedial basis.

But the problem exists in Kentucky and certainly in the South that we do not have trained math and science teachers to put in the classroom. So you do find the teacher with just one or two classes in mathematics who would be teaching mathematics courses.

I think that that is certainly a turn-off for students, also.

Certainly a well-trained math teacher is what a student deserves who decides to take the course.

Mr. Kogovsek. Thank you very much for your testimony, Ms. McDonald.

At this time the committee stands adjourned.

[Whereupon, at 12:37 p.m., the subcommittee was adjourned, subject to the call of the Chair.]

[Additional material for record follows:]

PREPARED STATEMENT OF HON. LEON E. PANETTA, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

The economic statistics of these difficult times have become typically familiar, but the statistics on math and science education, which are integrally related to our current economic hardship, have until now not received the same amount of attention. Only recently have we become familiar with the fact that over the past 15 years, Japan and West Germany have doubled their output of scientists and engineers, while the decade of the 1970's saw the number of Ph. D.'s in physics awarded by American universities drop by almost half; the fact that Japan, with only half our population, now graduates more engineers than we do; and the figures on the serious shortage of math and science teachers on the elementary and secondary as well as college and university levels.

The prescription for this alarming situation is clear: The federal government must spark a new commitment to math and science education similar to that which followed the launch of the first Sputnik. H.R. 30 represents an excellent initiative for focusing national attention and effort on this problem, and for developing corrective measures on the elementary and secondary levels as well as in higher education. I commend Chairman Perkins, Congressmen Simon and Goodling and the others who have worked on this measure, which has already received a large degree of bipartisan support, and hope that it will gain quick approval.

However, I would like to focus today on one aspect of the math/science education issue which, in spite of the current debate, has not in my view received adequate attention. This is the matter of the math/science "gender gap," the tremendous disparity in the number of males and females who study these subjects and who pursue careers which are math- or science-related. The decline of math and science among our nation's students is alarming, but the statistics on women and girls are staggering in their implications.

On the elementary and secondary level: Girls consistently score 50 points lower than boys on the math sections of the Scholastic Aptitude Test usually required for college admission, although scores on the verbal sections are basically equivalent. 4 percent of boys but only 1 percent of girls score between 700 and 800 (the top score) in math; 16 percent of boys but only 8 percent of girls score between 600 and 699. Obviously this has a significant effect on the quality of higher education which these girls are able to receive, and on their subsequent careers. Of the one million college-bound students who took the SAT's in 1981, two-thirds of the boys but only one-half of the girls had four years of high school math—a necessity for a college degree in most math- or science-related fields, and advisable for many other areas of study as well.

In higher education: Women earned 350 bachelor's degrees in engineering in 1970, 0.7 percent of the total. By 1980 that number had risen only to 6,100, 10 percent of the total. In 1980–81, the mean score on the quantitative section of the Graduate Record Examination (GRE), required for admission to most graduate programs, was 563 of a possible 800 for males, but only 484 for females. In 1979–80, doctorates in math were awarded to 624 men and 100 women (13.8 percent of the total); in physics, to 756 men and 62 women (7.6 percent); in engineering, to 2,412 men and 95 women (3.8 percent).

In the professions: In 1980, only 4 percent of engineers were women; women averaged 11.4 percent across all science and engineering fields. A study cited in Science magazine in 1981 found that women had higher unemployment rates and lower salaries than men in all fields of science and engineering, at all degree levels, and at all levels of experience, and that these disparities widened with higher degree levels and with years of experience. The study concluded, "Graduate enrollments indicate continuing increases over at least the next several years in degree awards to women, but their access to equal employment and advancement opportunities is not yet assured." Overall, women earn $0.59 for every dollar earned by men.

The question of whether the inherent math/science abilities of males and females differ is still unresolved, although recent studies have found that boys are no better than girls at mathematical reasoning. In fact, most studies have found no differences in achievement through the junior high school level, although significant differences develop by the end of high school—differences which may well be due to boys' higher participation in math classes and activities, rather than to biological factors.

What is clear, however, is that social and educational factors play a major role in girls' decisions to enroll in math and science at the secondary school level and in their progress in these courses, and thus influence heavily their participation in higher levels of math/science education and the shape of their future careers. One Educational Testing Service researcher found so-called "math anxiety" not among female high school students, but among teachers and counselors who refrain from encouraging even talented girls to pursue math- and science-related educations and careers. The study also found that girls who take advanced placement high school math courses often choose not to take the College Board Advanced Placement examination, which can translate that achievement into college credit or placement. A

University of Michigan researcher found that girls are twice as likely as boys to drop math in high school, regardless of their ability. A Northwestern University researcher noted that even the most talented and productive female math students get "mixed messages" from educators concerning possible careers in math. Obviously, the truth about inherent sex-related differences in math and science ability cannot be determined until the external factors, the disparities in educational treatment and social acceptance, are eliminated.

Clearly, the funds authorized under H.R. 30 can be used to help correct this situation. Teachers can be made more aware of the different treatment given to males and females in math/science education, and of the need to attract and retain girls' and women's interest in these fields. Programs can be developed on all educational levels to increase women's knowledge and skills in math and science, and to boost their self-confidence in pursuing careers in these fields.

Such efforts must not be viewed simply as a gesture to women, or even simply as a matter of equity. It is a question of maintaining the principle of equal opportunity in education and in the workplace, but it is also a question of economic necessity. We simply cannot afford to waste the talents of any of our young people if our economy is to recover and our productivity to increase. I am hopeful that H.R. 30 and other efforts now underway to improve the status of math and science education in this country will help to close this math/science "gender gap," will encourage girls and women with exceptional talents in math and science to make use of those abilities, and by widening their range of options and opportunities, improve the quality of life for all of us.

THE SECRETARY,
Washington, D.C.

HON. THOMAS P. O'NEILL, JR.,
Speaker of the House of Representatives,
Washington, D.C.

DEAR MR. SPEAKER: Enclosed for consideration of the Congress is a bill entitled the "Science and Mathematics Teacher Development Act of 1983." Also enclosed is a section-by-section analysis of the bill.

The purpose of the bill is to increase the competence of American secondary students in science and mathematics by narrowing the gap between the current supply of qualified secondary school teachers of science and mathematics and the current need for such teachers. The bill would authorize science and mathematics block grant assistance to States for scholarships to be awarded to individuals who can become qualified, within one year to teach science or mathematics at the secondary level, in grades nine through twelve.

I believe that in the past year or two the Nation has reached a broad consensus that our students should achieve increased competence in science and mathematics. However, there is a growing gap between the supply of teachers qualified to teach these subjects at the secondary school level and the need for such teachers. This is a significant barrier to improvement, and the gap will only widen as States and localities raise their standards and requirements for students in these subjects. Yet, I believe that raising standards and requirements is essential if we are to maintain America's technological edge, and prepare our young people to function effectively in tomorrow's technological society.

Testimony presented to the Department's National Commission on Excellence in Education by the President of the National Science Teachers Association (NSTA) sheds additional light on this subject. According to NSTA data, for the ten-year period

1971-1980 there was a 64 percent decline in the average number of science teachers trained annualy to teach in secondary schools. The comparable figure for mathematics teachers is 78 percent. Despite declining student enrollments, States continue to report shortages of math and science teachers. In addition, it has been estimated that there are about 10,000 individuals currently teaching math and science courses in secondary schools who are not fully qualified to do so.

These statistics point to the need to expand our pool of potential new math and science teachers to include teachers now certified in other subject and individuals from business and industry with subject matter competence but who lack pedagogical experience. This bill provides financial assistance that will enale such individuals to receive the necessary instruction to become qualified.

The bill would authorize assistance of $50 million per year for four years. The funds would be distributed to the States on the basis of the number of children aged fourteen through seventeen residing in the State—a formula designed to reflect the number of high school-aged students. Federally recognized Indian tribes would also be eligible to apply directly for block grant funds.

Under section 5 of the bill, any State desiring to receive a grant would be required to submit an annual Proposed Use Report. The purpose of this report is to assure accountability to the citizens of each State. In this report the State would describe how it would use the funds to address the purposes of the Act—that is, how the State's program would improve the quality of secondary school science and mathematics instruction by meeting the need for additional qualified teachers, especially in areas wher there is a shortage of teachers or where there are plans to increase science or mathematics enrollments or graduation requirements.

In those cases in which the State chose to operate the program through local educational agencies, the Proposed Use Report would describe how the funds would be distributed to local educational agencies. In addition to a number of standard assurances, the report would also describe how the State would provide students attending private secondary schools equitable opportunities to benefit from the State's program. Each report after the first would contain an assessment of the State's program. The bill would require the report to be made public prior to its submission to the Secretary.

Section 8 of the bill describes the authorized use of funds provided under this Act. It provides that the funds would be used for scholarships that would enable recipients to receive the instruction needed to become qualified to teach science or mathematics in public or private secondary schools.

The funds are intended for individuals who can quickly become qualified to teach science or mathematics. Eligible individuals must hold a bachelor's degree and must be able to become qualified to teach math or science at the secondary level within one year. Prime candidates for these scholarships include teachers currently qualified in fields other than science and mathematics, including those who are teaching mathematics or science courses on a provisional basis but are not certified in these subject areas who lack the academic preparation necessary to teach.

The assistance provided to a State under this Act could be used to pay for no more than $5,000 per individual scholarship. Although the bill would not require States or localities to match Federal funds, we anticipate that the funds provided under this Act would be supplemented by funds from State, local and private sources. With the assistance provided under this bill, we estimate that some 10,000 teachers could be trained each year.

In order to ensure that the funds are used to train individuals who will teach, the bill would reuire the State of local educational agencies to condition selection as a scholarship recipient upon that person'e agreement to teach science or mathematics for a reasonable period of time in a particular school. The bill would also authorize waiver or modification of these agreements in circumstances prescribed by the State or local educational agencies. The bill would not require scholarship recipients to teach for a specified number of years because we believe that the type of commitment to be required of recipients is a determination that is properly left to State and local discretion.

In requiring a State to provide for equitable opportunities to students attending private secondary schools to benefit from the State's program, the bill makes it clear that no funds provided under this Act could be used for religious worship, instruction, proselytization, or any activity of a school of divinity. The bill would also require the State to take account of the relative numbers and needs of these students in providing for their equitable participation in the program.

The bill also includes provisions which would make certain sections of the General Education Provisions Act applicable (section 6); require each State to provide for audits every two years of all activities supported under this Act (section 7); and define a number of terms used in the Act (section 11). Section 12 would provide that the Act shall take effect October 1, 1983 and shall expire October 1, 1987. The bill does not contain a nondiscrimination provision because the programs and activities funded under this Act would be subject to the civil rights statutes as programs and activities receiving Federal financial assistance.

The Department of Education recommends prompt and favorable action on this bill. This bill would improve the quality of education by providing immediate assistance to States and localities to met their critial and growing needs for additional qualified science and mathematics teachers.

The Office of Management and Budget advises the enactment of this proposed legislation would be in accord with the program of the President.

An identical letter is being sent to the president of the Senate.

Sincerely,

T. H. Bell.

A Bill

To increase the competence of American secondary students in science and mathematics by narrowing the gap between the current supply of qualified teachers of science and mathematics at the secondary level and the current need for such teachers, and for other purposes.

Be it enacted by the Senate and the House of Representatives of the United States in Congress assembled, That this Act may be cited as the "Science and Mathematics Teacher Development Act of 1983".

PURPOSE

Sec. 2. The purpose of this Act is to improve the quality of science and mathematics instruction in the United States by helping States and localities meet the critical need for additional qualified science and mathematics teachers at the secondary level, particularly in areas where there is a shortage of such teachers, and by making it possible for States and localities to increase science or mathematics enrollments or graduation requirements at the secondary level.

AUTHORIZATION OF APPROPRIATIONS

Sec. 3. For the purpose of carrying out this Act there are authorized to be appropriated $50,000,000 for each of fiscal years 1984, 1985, 1986, and 1987.

STATE ALLOTMENTS

Sec. 4. (a) From the funds appropriated under Section 3 for any fiscal year, the Secretary may reserve not more than one per centum for grants to the Insular Areas. The Secretary shall apportion the amount reserved for the Insular Areas according to their respective needs for assistance.

(b) From the remainder, the Secretary shall allot to each State (excluding the Insular Areas) an amount which bears the same ratio to that remainder as the number of persons aged fourteen through seventeen, inclusive, residing in the State bears to the number of those persons in all the States (excluding the Insular Areas).

(c)(1) The Secretary may reallot all or a portion of a State's allotment for any fiscal year if the State does not submit a Proposed Use Report under section 5, or informs the Secretary that it does not need the full amount of its allotment for that fiscal year. The Secretary may fix one or more dates during a fiscal year upon which to make reallotments.

(2) The Secretary may reallot funds to one or more States that have a current need for additional funds under this Act. Any funds realloted to another State shall be deemed not to be part of its regular allotment for the fiscal year in which it receives the reallotted funds.

(d) For the purpose of determining allotments under this section, the population aged fourteen through seventeen, inclusive, residing in any State shall be based on the latest data that are satisfactory to the Secretary.

(e)(1) The Secretary shall allot to each Indian tribe, which submits a Proposed Use Report that meets the requirements of section 5, an amount which bears the same ratio to the allotment of the State or States in which the tribe is located as the number of members of the Indian tribe aged fourteen through seventeen, inclusive, residing in that State or States bears to the number of persons aged fourteen through seventeen, inclusive, residing in the State or States.

(2) The Secretary shall reduce the amount allotted to a State or States under subsection (b) by the amount allotted to an Indian tribe under paragraph (1).

(3) For purposes of this subsection, the term "Indian tribe" means any Indian tribe, band, nation, or other organized group or community, including any Alaska Native village, which is recognized by the Secretary of the Interior as having special rights and responsibilities, and is recognized as eligible for the unique services provided by the Division of Indian Affairs to Indians because of their status as Indians.

PROPOSED USE REPORT

Sec. 5. (a) Any State desiring to receive a grant authorized by this Act during any fiscal year shall submit to the Secretary an annual Proposed Use Report which describes how the funds under this Act will be used. The Proposed Use Report must—

(1) describe—

(A) how the State's program will achieve the purposes of this Act, as well as the State's specific goals;

(B)(i) how the funds awarded under this Act will be used by the State, or

(ii) to the extent the State will not operate the program directly, how funds will be distributed to local educational agencies; and

(C) how the State will provide secondary level students attending private schools equitable opportunities to benefit from the State's program.

(2) contain assurances that the State will—

(A) provide for such methods of administration as are necessary for the proper and efficient administration of programs under this Act;

(B) provide for such fiscal control and fund accounting procedures as are necessary to ensure proper disbursement and use of Federal funds paid to the State; and

(C) maintain continuing public administrative direction and control over funds used to benefit students attending private schools.

(b) Each Proposed Use Report (after the first) must contain an assessment of the success of the State's program during the preceding year, including an assessment of the extent to which the State met the purposes of this Act as well as the specific goals it established for that preceding year.

(c) Prior to submitting the Proposed Use Report to the Secretary the State shall make it public in a manner that facilitates comment from interested agencies, groups, and individuals.

GENERAL EDUCATION PROVISIONS

Sec. 6. Only the following sections of the General Education Provisions Act shall apply to programs and activities conducted under this Act: sections 412(a) and (b), 415, 416, 417, 420, 422(a) (1) and (2), 426(a), 432, 437, 438, 439, 440, 451, 452, 454, 455, and 456.

AUDITS

Sec. 7. Each State shall provide for independent financial and compliance audits of all programs and activities supported with Federal funds awarded under this Act. These audits shall be conducted at least every two years and in accordance with standards prescribed by the Comptroller General. Reports of those audits shall be available to the public.

USE OF FUNDS

Sec. 8. (a) The State shall use its grant, either directly or through local educational agencies, to increase the number of teachers who are qualified to teach science or mathematics at the secondary level in public or private schools, by awarding scholarships which will enable the recipients to receive necessary instruction at institutions of higher education.

(b)1) For each scholarship recipient a State may use funds under this Act to pay a portion or the total amount of the scholarship (including tuition and stipend) provided to the recipient to enable the recipient to acquire the necessary qualifications to teach science or mathematics at the secondary level.

(2) A State may not use funds under this Act to provide instruction to a scholarship recipient for more than one period of twelve consecutive months or to pay more than $5,000 toward the total amount of the scholarship.

SCHOLARSHIP RECIPIENTS

Sec. 9. (a) A State may select as a scholarship recipient only a person who at the time the scholarship is awarded—

(1) has at least a Bachelor's degree; and

(2) lacks the qualifications to teach science or mathematics at the secondary level in public or private schools in that State, but can become qualified within one year.

(b) A State or local educational agency (unless the State determines otherwise) shall condition selection as a scholarship recipient upon that person's agreement to teach science or mathematics at the secondary level for a reasonable period of time in a public or private school determined by the State or the local educational agency to have a need for such a teacher. A State or local educational agency may waive or modify a scholarship recipient's agreement in circumstances prescribed by the State or local educational agency.

(c) A State may require a local educational agency or private school at which a scholarship recipient will teach to contribute a portion of the total amount of the scholarship (including tuition and stipend).

(d) Nothing in this Act shall be construed to require a scholarship recipient to become certified under State law.

PARTICIPATION OF STUDENTS IN PRIVATE SECONDARY SCHOOLS

Sec. 10. (a) The State shall provide to secondary level students attending private schools opportunities to benefit from its program that are equitable compared to the opportunities offered to secondary level students attending public schools, taking into account the relative numbers and needs of those student populations.

(b) No funds under this Act may be used for any religious worship, instruction, or proselytization, or any activity of a school or department of divinity.

DEFINITIONS

Sec. 11. As used in this Act—

(1) The term "State" includes, in addition to the several States, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, American Samoa, the Northern Mariana Islands, and the Trust Territory of the Pacific Islands.

(2) The term "secondary level" means grades nine through twelve.

(3) The term "science" means the natural sciences.

(4) The term "mathematics" means all branches of mathematics, including computer science.

(5) The term "local educational agency" means—

(A) a public board of education or other public authority legally constituted within a State for either administrative control of or direction of, or to perform service functions for, public secondary schools in—

(i) a city, county, township, school district, or other political subdivision of a State; or

(ii) such combination of school districts or counties a State recognizes as an administrative agency for its public secondary schools; or

(B) any other public institution or agency that has administrative control and direction of a public secondary school.

(6) The term "Insular area" means Guam, American Samoa, the Virgin Islands, the Northern Mariana Islands, and the Trust Territory of the Pacific Islands.

(7) The term "institution of higher education" means an institution of higher education as defined by section 1201 of the Higher Education Act of 1965, as amended.

(8) The term "school or department of divinity" means an institution or component of an institution whose program is specifically for the education of students to prepare them to enter into a religious vocation or prepare them to teach theological subjects.

EFFECTIVE DATE AND EXPIRATION DATE

Sec. 12. This Act shall take effect on October 1, 1983, and shall expire on October 1, 1987.

SCIENCE AND MATHEMATICS TEACHER DEVELOPMENT ACT

SECTION-BY-SECTION ANALYSIS

Section 2. Section 2 of the bill would state the purpose of the Act to be the improvement of the quality of science and mathematics instruction in the United States by helping States and localities to meet the critical need for additional numbers of such teachers at the secondary level, particularly in areas where there is a shortage of such teachers, and by making it possible for States and localities to increase science or mathematics enrollments or graduation requirements at the secondary level. To accomplish this purpose, the Act would authorize assistance to States to pay the costs of scholarships for persons to qualify as teachers of science or mathematics at the secondary level.

Section 3. Section 3 of the bill would authorize annual appropriations under this Act of $50,000,000 for fiscal years 1984 through 1987.

Section 4. Section 4 of the bill would prescribe how funds appropriated under this Act would be allotted to the States and Insular Areas. First, the Secretary would be authorized to reserve for grants to the Insular Areas not more than one percent of the amount appropriated. From the remainder, the Secretary would be required to allot funds to the States according to the ratio that the number of persons aged fourteen through seventeen, inclusive, residing in the State bears to the number of such persons residing in all of the States. If a State chose not to participate in this program, or indicated that it would not need the full amount of its allotment for any fiscal year, the Secretary would be authorized to reallot those funds to one or more States that had a current need for the funds. In addition, federally recognized Indian tribes would be authorized to receive funds directly under this Act.

Section 5. Section 5 of the bill describes the annual Proposed Use Report a State would be required to submit to the Secretary in order to participate in this program. The report would describe how the funds under this Act will be used. In addition, the report would describe how the States would achieve the general purposes of the Act as well as the State's specific goals; how the State would use the funds awarded under the Act, or, to the extent the State did not operate the program directly, how funds would be distributed to local educational agencies; and how the State would provide secondary level students attending private schools equitable opportunities to benefit from the State's program. The report would also include assurances regarding proper administration, fiscal control, and accounting procedures. Each report, after the first, would contain an assessment of the success of the State's program during the preceding fiscal year. The report would be made public in the State.

Section 6. Section 6 of the bill would make certain sections of the General Education Provisions Act applicable to programs and activities conducted under this Act.

Section 7. Section 7 of the bill would provide for independent audits of all programs and activities supported with Federal funds awarded under this Act.

Section 8. Section 8 of the bill would provide for the use of funds awarded under the Act. The State would be required to use its grant. either directly or through local educational agencies, to increase the number of teachers who are qualified to teach science or mathematics at the secondary level in public or private schools in the State, by awarding scholarships which would enable recipients to receive necessary instruction at institutions of higher education. A State would be authorized to use funds awarded under the Act to pay a portion or the total amount of each scholarship (including tuition and stipend). The period covered by a scholarship would be no more than one period of twelve consecutive months, and the Federal funds would pay no more than $5,000 toward the total amount of the scholarship.

Section 9. Section 9 of the bill would require that scholarship recipients have at least a Bachelor's degree and, at the time the scholarship is awarded, lack qualifications to teach science or mathematics at the secondary level, but be able to become qualified within one year. In order to ensure that the secondary school populations with the greatest need for additional science or mathematics teachers benefit from this program, a State or a local educational agency would be required to condition selection as a scholarship recipient upon the recipient's agreement to teach science or mathematics at the secondary level for a reasonable period of time in a public or private school determined by the State or the local educational agency to have a need for such a teacher. In addition, a State would be authorized to require a local educational agency or private school at which a scholarship recipient would teach to contribute a portion of the total amount of the scholarship. The bill clarifies that it would not require a scholarship recipient to become certified under State law.

Section 10. Section 10 of the bill would require the State to provide secondary level students attending private schools opportunities to benefit from its program. These opportunities would have to be equitable compared to the opportunities offered to secondary level students attending public schools, taking into account the relative numbers and needs of those student populations. Section 11 would also prohibit funds awarded under this Act from being used for any religious worship, instruction, or proselytization, or any activity of a school or department of divinity.

Section 11. Section 11 of the bill would define a number of terms used in the Act. The terms "science" would be defined as the natural sciences and "mathematics" as all branches of mathematics, including computer science. The term "secondary level" would be defined to mean grades nine through twelve.

Section 12. Section 12 of the bill would set an effective date of October 1, 1983 for the Act and an expiration date of October 1, 1987.

Prepared Statement of Gov. Edmund G. Brown Jr., Governor, State of California

We are now in the midst of a revolution that will surpass in its magnitude the industrial revolution of the 19th century. Driven by advances in microelectronics and telecommunications, our society is transforming itself and fundamentally changing the way it works and organizes itself.

The evidence for this revolution is most clear if you examine the changing structure of our workforce: in 1870, 70 percent of all Americans worked on farms; today just 3 percent do. Rather, 70 percent of all Americans today work in the service sector of our economy—that is, they manage information.

As these statistics illustrate, in the post-industrial economy, wealth will not derive from a mere abundance of resources but from people—from human intelligence. Innovation—the source of increased productivity, and therefore of qualitative growth—comes from human creativity. It is imperative that the United States invest in people in order to preserve its leadership in technological innovation.

The need for sound investment in education and job training is dramatized by two factors: the large number of jobs which will be affected by the new technologies and the jobs which will disappear as a result of modernization.

Our first need will be to educate millions of people in technical, engineering and computer science fields. The Bureau of Labor Statistics reports that the greatest job growth in the 1980s will be in such careers as computer programming, engineering and related fields.

We will also need to provide more sophisticated education for millions more office workers. The Xerox Cororation has estimated that over 60 percent of the workers in the next ten years will require a familiarity with computers to perform their job.

As the new technologies spread into the manufacturing sectors, many existing jobs will either disappear or significantly change character. Business Week magazine estimates that over 45 million American jobs will disappear or change significantly because of technology during the next two decades.

What this adds up to is a need for a massive investment in education and job-training and retraining in this decade.

As a first step, we must set as a national goal that we equal the educational achievements of our international competitors. Presently, we lag seriously behind as these statistics indicate:

The school year in Europe and Japan is anywhere from one to two months longer than the school year in the United States.

American students study one-third to one-half the math and science studied by young people in Japan and the Soviet Union.

The National Science Foundation reports that five million Soviet students study calculus in high school, compared to only 500,000 Americans studying calculus in high school or college.

The National Council of Mathematics Teachers and the National Science Teachers Association report that 50 percent of the teachers being hired to teach math and physics are unqualified.

Japan graduates more electronic engineers per year than we do, with half the population.

Clearly, what we have here is a national crisis of monumental proportions. And there is no quick, cheap or easy fix to this decline in educational standards and achievement. We need to mobilize the national will to invest in education and job-training.

Unfortunately, the need for investment comes at a time when current fiscal realities have led to a declining revenue base for our education system. Our schools are characterized by shortages of qualified teachers, inadequate classroom space, outdated curricula and obsolete equipment. The Federal Government is decimating its support and leadership, while State treasuries nationwide are being drained by the recession. Private sector support has focused only on the apex of the educational system, the universities. We must reverse this tide—the Federal, State and local governments, labor and business must join hands to invest in education and job training.

I am proud to say that in California, during my last year as Governor, we did mobilize the will to invest in people even during times of budget cuts. A year ago last January, I introduced a program called "Investment in People." I am enclosing a summary of this program, so I will only review it very quickly here.

This program designated $132 million in funding for education and job-training programs for Californians. The program covers four areas:

1. Elementary and Secondary Schools: I joined with the State Board of Education and the Superintendent of Public Instruction to call for higher math and science standards in the schools of California. This year, the Board of Education has taken up the call and issued model high school graduation requirements which include three years each of math and science, and one semester of computer science, in addition to English, history and foreign language.

The major obstacle to the implementation of these standards is a serious teacher shortage in California, and in the United States. Therefore, funds were allocated to train teachers in mathermatics and science and to improve the skills of existing math and science teachers.

Almost $10 million was allocated for a statewide network of 15 Teacher Education and Computer Centers, along with 44 satellite locations, to provide in-service training for teachers in math, science and computer studies. In the last six months alone 270 teachers were trained as credentialed math teachers. Twenty-five percent of the secondary schools are being supported as they purchase inservice training for teachers in math, science and computer education. In addition to the fifteen regional Computer Demonstration Centers, a statewide software clearinghouse, has been established to purchase, evaluate and disseminate computer software.

To further aid schools in their purchase of computers, I also signed legislation which provides a tax credit of 25 percent of the fair market value of a computer donated to schools. It is my hope that by the time this tax credit expires in June of 1984, 40,000 computers will have been provided to California's primary and secondary schools. This is a relatively modest goal, but one that is reasonable given the quantity and quality of trained teachers in the state.

2. Job-training: In 1979, I created the California Worksite Education and Training Act (CWETA) to tie jobs and training more closely together. CWETA is a unique program because it is based on the real life demands of specific businesses. Instead of providing funds to train workers irrespective of the existence of employment, CWETA begins with an employer who needs workers and who commits to hire or upgrade those completing a specially designed training program given through a local community college. Through CWETA, 12,000 Californians have been trained to work in growing industries such as electronics, aerospace and health. More than 2,500 employers, and 27 community college campuses have participated in the program since its inception.

The Investment in People program funded an expansion in CWETA-type programs initiated by the community colleges. In addition, four business/labor advisory councils were funded on a pilot basis to review community college curricula for their relevance to the changing workplace.

3. Training for Displaced Workers: The Investment in People program also included funds for increased employment preparation and job search assistance programs for displaced workers. More than twenty Displaced Workers Reemployment Centers have been established around the state, with support from private industry. In one such effort, General Motors and the United Auto Workers have contributed $8 million to retrain workers.

In addition, I signed legislation to set aside $55 million of the state's Unemployment Insurance fund for job training for displaced workers. This money will be allocated to worksite based training, following the concept of the CWETA program outlined above.

4. University Education: Our universities are suffering from inadequate classroom space, obsolete equipment, and shortages of qualified faculty which prevent many students from receiving training in engineering and computer science. To enter an engineering program at the University of California requires a 4.0 Grade Point Average because the demand for these programs so far exceeds the capacity of the universities to supply them.

Therefore, the Investment in People program included a small amount of funding, $3.3 million, to update the California State University and University of California systems' engineering programs and to provide engineering scholarships. These funds have been used to match private sector donations. On one campus, California State University at San Luis Obispo, Investment in People funds established a Computer-Aided Productivity Center, attracting $1.5 million in private donations.

In addition to these funds, the University of California has received $4 million for the MICRO (Microelectronic Innovation and Computer Research Opportunities) program. This provides industry-university matching grants for basic research and an engineering and computer sciences scholarship program. The University of California, Berkley campus also received $2.3 million in funds to equip Cory Hall with state of the art microelectronics and computer-aided design equipment.

This package of initiatives illustrates the types of programs other States could adopt to prepare the nation's workforce for the information economy. The federal government's role should be to recommend standards of achievement, based on international comparisons, and to provide funds in the form of "technology education block grants" to help the States implement the programs needed to reach those standards. The private sector must also increase its involvement in education and job-training at all levels, supplying computer hardware and software, trained faculty and research grants and equipment.

But money is not the only requirement to raise the educational standards of Americans. Our nation must also recapture its commitment to excellence, to discipline and to hard work. We have to transform ourselves once again into a nation of citizens, not mere consumers. For our goal, our shared vision, must be of a truly democratic society of informed people who use technology for human and spiritual values and participate in the basic decisions that affect our lives.

GREENUP COUNTY SCHOOLS,
Greenup, Ky., January 18, 1983.

CARL D. PERKINS,
House of Representatives,
Washington, D.C.

DEAR MR. PERKINS: I will gladly endorse H.R. 30, the Emergency Mathematics and Science Education Act, to improve mathematics and science instruction in the elementary and secondary schools.

We especially need assistance at the state or regional level in developing inservice education models for teachers grades six, seven, and eight. Many of our elementary teachers do not feel that they have the background to conduct adequate programs at this level for the more advanced students. Certainly, the better student should have completed Algebra I by the end of the eighth grade if they are to pursue a program in engineering, science, or mathematics.

At the present time, Greenup County High School has an adequate number of science teachers, but we are far short of the number needed in mathematics. We conduct thirty-five classes in mathematics and feel that if all the students needing advanced mathematics were in the desired classes, that we should be offering at least five or six more classes.

Of the thirty-five classes we do teach, twelve are taught by teachers without a major or minor in mathematics. We also had some difficulty in finding a teacher adequately prepared to teach computer literacy and programming classes. I am concerned that as the economy improves, we may lose some of our science teachers to more lucrative salaries in private industry.

Perhaps H.R. 30 will provide for inservice training of teachers currently employed by providing for tuition payments or stipends for workshops and summer institutes. The post-secondary provisions would help provide replacements for teachers lost to private industry as the economy improves.

I am sure that most Eastern Kentuckians approve of the President's plan for upgrading the Armed Forces and providing a stronger defense. Most of us would agree that the Armed Forces conduct good job training programs and provide valuable work experiences for all service personnel, but we do not believe that they should have to conduct remedial education programs or that they should have to teach basic science and mathematics classes.

The high technology weapons systems of today's Armed Forces are useless unless we have personnel with a sound background in science and mathematics to operate them. H.R. 30 will help insure the defense of our way of life and the nation.

Increased enrollment in science and mathematics classes that would come with improved programs would provide a better trained labor pool and encourage industries to locate in Eastern Kentucky. We need people trained in science and technology to make wiser use of our limited resources in this area.

Respectfully yours,

H. JACK WEBB,
Superintendent.

SUPERINTENDENT OF SCHOOLS,
West Liberty, Ky., January 17, 1983.

Congressman CARL D. PERKINS,
House of Representatives,
Washington, D.C.

DEAR MR. PERKINS: I was glad to hear the good news of your introduction of H.R. 30, The Emergency Mathematics and Science Education Act. This bill address the problem faced by many school administrators throughout the nation, fewer math teachers and science teachers for elementary and secondary schools.

As you are well aware, there defintely is a shortage of math and science teachers in the Commonwealth of Kentucky in spite of the grants offered through the Department of Education by Superintendent of Instruction, Raymond Barber. By providing funds to summer teacher institutes and funds for upgrading of laboratory equipment and facilities I feel this would give people the opportunity to better educate themselves and better to prepare our young people for the future.

In our own system this past school year I had a math teacher at the high school take a year leave of absence. The Morgan County Board of Education had a difficult task of finding a certified math teacher to replace this person.

Hopefully this bill will become a reality in the near future and if I can be of help please let me know.

Sincerely,

EARL REED,
Superintendent, Morgan County Schools.

WRITTEN STATEMENT BY FRANK PRESS, PRESIDENT, NATIONAL ACADEMY OF SCIENCES

Mr. Chairman, I am pleased to have this opportunity to present views on H.R. 30, a bill entitled the "Emergency Mathematics and Science Education Act." I would like to use this opportunity to comment not only upon the provisions of this proposed measure but also to share my concerns on the state of science and mathematics education, especially as they relate to our future economic and social development. As was recently pointed out by the National Science Board's Commission on Precollege Education in Mathematics, Science and Technology, "there is an escalating awareness that our educational systems are facing inordinate difficulties in trying to meet the needs of the nation in our changing and increasingly technological society."

It is gratifying that your Subcommittees have taken this step, Mr. Chairman, to recognize the need for national initiatives to confront the problem of falling school achievements in science and mathematics. Historically, as a nation we have repeatedly affirmed through our actions the role of education in making the best use of our human resources. We have valued excellence in education. Indeed, no nation has ever attempted what we have done: to create an educational system unparalleled in its scope, complexity, and ambitions.

Today, however, we have become acutely aware that our educational system is troubled. We are learning that the skills which at one time helped to ensure a lifetime of productive work have become in part anachronistic, made so by the rapid technological transformation now occuring in the American economy.

As you know, the National Academies of Sciences and Engineering sponsored a convocation in May 1982 to consider the state of precollege education in mathematics and science in the United States. Leaders from all levels of government, business and industry, labor, science and education spoke to their concerns that America's schools are failing to provide a majority of students with the knowledge and skills needed for productive lives in a changing technological world. The collective views of that convocation moved beyond the mere discussion of the issues, suggesting solutions and identifying institutional responsibilities for achieveing them.

The Bureau of Labor Statistics tells us that jobs requiring technological skills are among the fastest growing. Employment trends over the past several decades are especially revealing of the changes taking place. At the height of the war boom in the early 1940s, the goods-producing sectors of the U.S. economy accounted for 69 percent of the employed labor force; in 1980, they accounted for 32 percent.

The most publicized shift was the mechanization of agriculture. A second striking shift has occurred in manufacturing—from a high of 41 percent of all employment in 1943 down to 22 percent at present. Of all the new jobs added to the economy from 1969 to 1976, 90 percent were in services. Even the nature of jobs in the traditional smokestack industies (automobiles, chemicals and pharmaceuticals, textiles, etc.) is changing. For example, financial, legal, and accunting services, marketing, management consulting, and communications make up about 60 percent of the work force of General Electric; this means that only 40 percent of employees are engaged in the direct manufacture of the tens of thousands of General Electric products.

One speaker at the Academies' convocation stated that precollege mathematics and science education is as important today for nonprofessional jobs, such as technician, machine operator, plant mechanic, process operator, and the like, as it is for future scientists and engineers. Similar views were expressed by many senior corporate executives who attended this convocation. Such trends and the shift of the economy toward services will make it more difficult for the undereducated to find a niche in our society.

Yet what is happening in our school system presents a serious contradition. The evidence takes several forms, much of which was aptly summarized in the Committee's report in the last Congress on H.R. 7130. Some is quantitative: declines in Scholastic Aptitude Test (SAT) scores, declines in the number of high school graduates having taken a given number of years of science, and declines in the number of teachers certified to teach science and mathematics. Other evidence is qualitative: in particular, the disenchantment with science and mathematics as children progress through secondary schools indicates a profound weakness in the teaching of science and mathematics.

Decreasing course exposure to mathematics and science in our secondary schools is particularly alarming. At the secondary level, most mathematics and science courses offered are optional. Only one-third of the nation's school districts require more than one year of mathematics and one year of science for graduation. Of the roughly three million students who graduate from high school each year, about one-third have completed three years of mathematics, and only one-fifth have completed three years of science. Enrollment of high school students in science courses has declined in the last two decades: from 60 percent in 1960 to 48 percent in 1977.

Students who continue their education try to remedy the situation in college. Remedial mathematics courses in public four-year colleges increased by 72 percent between 1975 and 1980—they now make up one-quarter of all the mathematics courses in those colleges. At two-year colleges, 42 percent of the mathematics courses are remedial. There is evidence that the greater the need for remediation, the less likely it is that a student will enter science-related career preparation.

The shortage of qualified mathematics and science teachers is perhaps the most critical aspect of this educational crisis. In 1980, 28 states reported a shortage of mathematics teachers and by 1981, the number of states reporting a shortage had grown to 43. Similar teacher shortages exist for the physical sciences. During the 1970s, there was a 77 percent decline nationwide in the number of secondary school mathematics teachers being trained and a 65 percent decline in the number of secondary school science teachers being trained.

And the trained teachers who are in the classroom are leaving at a rapid rate. In 1981, almost five times more science and mathematics teachers left to take non-teaching jobs than left to retire. The replacements for these trained teachers are often inadequately prepared: of the teachers newly employed in 1981–82 to teach high school mathematics or science, 50 percent were formally unqualified and are teaching with emergency certificates.

A measure of the strengths and weaknesses of educational preparation of our youth in science and mathematics is a comparison with what other countries are doing. The post-World War II era has seen such countries as the USSR, East Germany, the People's Republic of China and Japan demonstrate their capacity for rapidly rebuilding and adjusting their educational system to an increasingly technological era. Their school year averages 240 days with minimal loss due to absences; the U.S. school year is typically scheduled for 180 days but actually averages about 160 days because of absences. Their students attend school 8 hours a day, 5½ to 6 days a week; U.S. children attend 6 to 5 hours a day, 5 days a week.

The time spent on mathematics and science, based on class hours, is approximately three times that spent by even the most science-oriented students in the United States—those who elect four years of science and mathematics in secondary school. A study by the New York Stock Exchange asserted that the single most important factor in Japan's high productivity and advanced technological growth is the emphasis which the Japanese place on primary and secondary education in those fields. I do not suggest that these models are necessarily appropriate for the United States but merely emphasize the importance attached by these countries to science and mathematics education.

The formulation of national educational goals is conditioned by the complexity of involving a wide range of both public and private institutions in any renewed national effort. The Federal role, itself dispersed among a number of agencies and Congressional committees, is one of cooperative endeavors with other levels of government to strengthen the partnership between education and industry and between scientists and education.

The proposed program initiatives assigned to the Department of Education in H.R. 30 are a major component of such a cooperative Federal venture. Quite appropriately, this hearing focuses on the national leadership role of the Department of Education in working with State and local governments to strengthen the nation's educational system. We must ensure that general grants for science and mathematics education administered by that Department support programs designed to accomplish the above goals and are sensitive to the plurality of responsibility shared with other institutions. As I am sure the Subcommittees recognize, other Federal agencies have a role to play in strengthening science and engineering education. It is my understanding that a companion bill, H.R. 582, entitled the "National Engineering and Science Personnel Act of 1983" has been introduced to strengthen the program contributions of the National Science Foundation to this endeavor.

The purposes enunciated in H.R. 30 are commendable objectives: to improve the quality of instruction and levels of achievement in mathematics and science at the elementary and secondary levels, and to increase and sustain the supply of qualified teachers. The National Defense Education Act of 1958 wouild seem an appropriate mechanism for equitably distributing Federal educational grants among State and local educational agencies to aid in serving these purposes. The accomplishments under that act symbolized the nation's successful response to a similar educational challenge of the post-sputnik era.

I shall defer to others on the adequacy or impact of the annual levels of general grant assistance made available under H.R. 30. I should note, however, that there are some 16,000 school districts in the United States among which grants authorized under Section 2 of H.R. 30 would be distributed. Thus limited Federal funds would be available to each school district. It is questionable that much can be accomplished with these limited resources unless local and state educational agencies substantially agument this support and are encouraged to combine their funds for jointly operated programs. At our convocation last year, one educator proposed a scheme whereby $982 million/year—from a variety of sources—would ensure that every elementary school in the country had a science-trained college graduate in contact with students from kindergarten to sixth grade.

The content of science courses also must be reshaped to be responsive to current training needs. For example, the need to understand the uses and functions of computers has become essential in most school curricula. The experience of industry in establishing courses to overcome educational deficiencies of employed secondary school graduates should be helpful to educators concerned with curricula development. Control Data, for example, through the use of computer-based education in its corporate vocational schools, considerably reduced the time required to acquire entry-level skills for technicians in computer maintenance operation and programming.

Past and current experience brings me to another important need, i.e., the involvement of academic, industrial and governmental scientists in the improvement of school science and mathematics. The Department of Education and the National Science Foundation should work together in ensuring that prospective teachers, as well as students, are brought into contact with scientists and engineers in universities, research laboratories and industry.

The provisions of H.R. 30 concerned with sponsorship of summer institutes and workshops and with programs to upgrade laboratory equipment and facilities also are areas of mutual interest to both the Department of Education and the National Science Foundation. In this regard, I am pleased that Congressman Fuqua in his statement at these hearings has pledged the cooperation of his committee in assuring that the Foundation's responsibilities for maintaining the health of science and engineering education, and its past experience, are fully utilized in this endeavor.

H.R. 30 also addresses another deficiency in the educational system, i.e., the long- and short-term problems of a growing shortage of qualified science and mathematics teachers. For the long term, H.R. 30 makes provisions for a limited number of scholarships for young people interested in teaching careers at the secondary school level. The designation in the measure of annual Congressional scholarships would underscore Federal concerns and is an interesting proposal concerning the type of public recognition and national visibility that is needed to improve the status of teaching.

Innovative ways of coping with the immediate short-term shortage were discussed at the Academies' convocation last May. Examples of how this may be accomplished include the use of unversity students and scientists and engineers from industry to help alleviate the teaching shortage, bringing working scientists into the classroom, and strengthening ties between schools, industry and institutions of higher learning. Another suggestion was made that science-trained college graduates work in elementary school classrooms in exchange for fellowships for further study.

Equally important is the need to find ways to keep teachers in the profession and make available to the means for keeping abreast of changes in their disciplines. Grants made available to local educational agencies could be used to provide in-service training for teachers. Teachers should be encouraged to participate in conventions, conferences, workshops, and teacher exchanges, and be given time and financial means to do so. As an example, work in industry, government, or university laboratories during the summer or during part of the school year on a released time basis should be available to teachers. The interaction of teachers in secondary schools with working scientists and engineers in both universities and industry would provide important learning opportunities for meeting this objective. The renewal of their knowledge and the enthusiasm they will bring back to the classroom will justify the break in continuity and learning while they are away.

Awards to honor outstanding teachers and schools also offer another means for providing needed public recognition to the teaching profession.

I believe, Mr. Chairman, that general agreement exists on the nature of the challenges we are discussing at these hearings. At issue, however, is the adequacy of the mechanisms to accomplish the goals we have established. Certainly, additional Federal support funds for education, if properly targeted, can make a difference. Improving the knowledge and skills of those who teach science and mathematics, suporting young promising faculty, providing information to educators on responses that have been applied elsewhere, and making available facilities and instrumentation that permit school training to keep apace of the rapid changes in science and technology—all necessitate substantial investments.

To work, however, funds must be distributed equitably and deservedly; funds also must be provided in a manner that will ensure excellence in their use and in their outcome. It is not clear to me that existing or proposed legislative mechanisms provide sufficient means for engaging scientists, engineers and science educators in the bill's goals. Without this guarantee, I believe the bill risks its intention. Our responses to similar challenges in the post-sputnik era, a quarter century ago, were characterized by some remarkably successful accomplishments, many of which were largely attributable to the role played by the scientific and technical communities.

In closing my remarks, I urge the Subcommittees to consider several questions in shaping final legislation and in ensuring that Federal investments are targeted in ways that make a difference. Does it provide for engaging our very best scientists and engineers and teachers in what is rightly called the American crisis in education? Does it encourage improving the quality of preparation of our teachers over their degree of understanding of subject matter? Does it encourage standards which teachers must meet before being qualified to teach or continue teaching? Does it consider the lessons, both successes and failures, learned from the earlier challenge in 1958 and permit their application to present situations? Does it provide the flexibility and the oversight to enable us to adjust our policies to new realities? And finally, does it merely reinforce the current means and methods that apparently have not worked; or does it encourage innovation?

We have awakened to the need for a new beginning. This hearing and the intent of the proposed measure before you provide opportunities for contributions at the Federal level for translating our concerns into effective action. We at the Academies and the National Research Council are pleased to work towards making this national endeavor a successful one and pledge our full cooperation in support of Federal initiatives that emerge from legislative action of the Congress.

Statement of the Great Lakes Colleges Association and the Associated Colleges of the Midwest

The Great Lakes Colleges Association and the Associated Colleges of the Midwest [1] applaud the attention which this committee is giving to science education at the elementary and secondary levels. We have a serious national problem of quality in science education, and a national response is both necessary and appropriate.

Science, from early elementary education to the most advanced research, is a seamless web. Every part is necessary for our nation' strength and productivity. Improving the obvious problems in elementary and secondary science and mathematics education, and increasing support for basic research, will not deal with the whole problem. Attention must also be given to the vital link of undergraduate education, where teachers are trained and where scientists set their careers.

The role of our colleges in the education of scientists and of teachers of science gives us some particular perspectives which may be useful to the committee as it considers the proper national response to these problems.

The essential issue is one of quality. Science education, at every level, must be designed and presented with the active and central involvement of the practitioners, the scientist themselves. Keeping course content current and accurate is the key to quality.

It would be useful, therefore, that any program to improve science education which is undertaken by the federal government involve the National Science Foundation, with its scientifically trained staff and access to scientists around the country, as well as the Department of Education, in its design and administration. National programs to improve science education should involve scientists from higher education institutions and from industry with our elementary and secondary schools. Institutions which have a strong record in the education of scientists, especially quality undergraduate colleges, should be included among the sites used in the further training of elementary and secondary science teachers, to bring up their level of knowledge and skills.

---

[1] The Great Lakes Colleges Association is a consortium of twelve undergraduate liberal arts colleges: DePauw, Earlham and Wabash in Indiana; Albion, Hope, and Kalamazoo in Michigan; and Antioch, Denison, Kenyon, Oberlin, Ohio Wesleyan and the College of Wooster in Ohio. The Associated Colleges of the Midwest includes thirteen undergraduate colleges: Colorado College; Knox, Lake Forest, and Monmouth in Illinois; Coe, Cornell and Grinnell in Iowa; Carleton, Macalester, and Saint Olaf in Minnesota; and Beloit, Lawrence, and Ripon in Wisconsin.

Providing basic education in science and mathematics and the further education needed for those who choose careers in science are parts of a single process. We have dramatic and urgent problems of science literacy at the elementary and secondary levels. The focus of this committee on that set of problems is reasonable and timely. But to deal with those problems, our national policies must recognize the necessity to improve every phase of the science education process. The undergraduate years, when well-prepared students choose and begin careers as scientists are one essential stage in the process and the needs at that level, as well as in graduate training and research support, also require attention.

Better education of teachers of science is an obvious and crucial part of the solution of our urgent problems at the elementary and secondary levels. An unfortunate trend in the training and certification of teachers has been to add more and more course requirements in the process and method of teaching. The goal has been better quality teaching. Unfortunately, this trend has crowded out the even more important courses in content. This is especially acute in the sciences, where the content is not only complex and changing but requires considerable time to master. Many of the best undergraduate colleges have been forced out of teacher preparation and certification because they have been unwilling to compromise their insistence that students gain a depth and breadth of knowledge, a requirement which does not leave time for the increasing number of teacher certification requirements dealing with process rather than content. Knowledge of science must be the first goal of teachers of science. An important clue to our problem in science education is that this should need to be said at all.

H.R. 30 does address, in section 625, one of the most seious problems in the education of scientists at the postsecondary level: upgrading laboratory equipment and facilities. Rapid changes in many scientific fields, and the high cost of much contemporary equipment, have made it impossible for most institutions to keep their teaching laboratories up-to-date. Assistance in this area will help enormously. The provision to assist with challenge grants, rather than the federal government covering the entire cost of new equipment, is most appropriate. This will insure that the new equipment which is acquired will be used efficiently, and will magnify the results of the federal investment.

The associated Colleges of the Midwest and Great Lakes Colleges Association applaud this committee's attention to science education at the elementary and secondary levels. The essential issue is quality. Quality science education is only possible with the active involvement of scientists. The committee must insist on that. The education of teachers of science, which must be a continuing process throughout their professional lives, should involve our best colleges and universities, those where most of our scientists are also educated. That, too, will contribute to quality. Finally, everything we do in science education must recognize that science is a continuous process which begins with a child's first exposure to science and mathematics and continues through the education of those who choose to become scientists and teachers of science, and on to their unending professional renewal and development. We cannot address problems in only one part of this process and consider the job done. we have a national interest in the quality of every step in science education and the education of scientists.

PREPARED STATEMENT OF BRUCE CHRISTENSEN, PRESIDENT, NATIONAL ASSOCIATION OF PUBLIC TELEVISION STATIONS

Mr. Chairman, I appreciate the opportunity to describe the potential of public service television for fulfilling the objectives of the Emergency Mathematics and Science Education Act. Throughout this nation's noncommercial educational television system, there is serious concern about the problem you and your Committee are addressing. More importantly, there is a concomitant commitment to share a greater role in the solution.

A brief overview of educational television—of yesterday, as it serves our citizens today and the potential contributions it can make to tomorrow's needs—might be useful.

Although public television is fifteen years old at the national level, educational television is thirty years old at the state and local level. When Congress enacted the Public Broadcasting Act of 1967, state and local governments provided nearly 60 percent of our financial support, most of which they designated for instructional programming. Since that time, the number of stations has more than doubled so that we now serve well over 90 percent of the U.S. population. Along with business and voluntary viewer contributions, state and local governmental and educational support has grown, from $33 million in 1966 to $218 million in 1980. Over fifteen million K-12 students in one third of our nation's classrooms are regular users of instructional television. And in its first year, over 55,000 college credit students at 555 colleges and universities throughout the country have benefitted from the Public Broadcasting Service's Adult Learning Service.

While the cost of providing instructional programming traditionally has been borne at the state and local level, the federal government has played a critical role in financing much of our most important educational programming, especially in the science area. The Department of Education alone provided a total of $49 million over many years to fund the development of Sesame Street and The Electric Company—"two of the best things the Office of Education ever invested in" according to then Commissioner Terrel Bell. In the science area, 3-2-1 Contact was a combined effort of the Department of Education and the National Science Foundation and NOVA was initiated through the support of the NSF. The broadcasting of programs such as the Ascent of Man, Cosmos, NOVA, Nature, Life on Earth and the Body in Question has made our public television system the most consistent reliable source of quality science information available to Americans today. And as we evolve into a society increasingly based on expertise in science and high technology, public service television can play a critical role in breaking down the barriers of privileged access—this knowledge enrusing an equal opportunity to science computer and math literacy by providing access to all rather than permitting the development of a new information and technology elite.

The instructional television programming provided by over 90 percent of our licenses has been developed by teachers, in response to the concerns of teachers and as a companion to the classroom environment. Elementary and junior high school science programs, ranging from Hands On and Animals and Such to Community of Living Things, from public television station WHRO in Norfolk, were produced, designed and narrated by Larry Crum, a former biology and earth science teacher in the Virginia public schools. Wisconsin ETV's Mathways was designed to calm common math anxieties by presenting troublesome math theories—from areas of circles to volumes of cylinders—in an animated manner. Similarly, Kentucky Educational Television's Math County gives extra attention to concepts teachers find difficult to present in the classroom; it was developed in response to concerns of the National Council of Teachers of Mathematics. WDCN in Nashville developed Discovering to correlate with widely adopted classroom science texts, enhancing the value of the text material with on-camera experiments and action footage designed to arouse curiosity, stimulate investigation and encourage students to think in a scientific way.

Particularly in the science and math area, instructional television can help diminish the fear of failure and demystify far away places and experiences. Math Matters, produced by KLRN, Austin-San Antonio, is designed to inspire students who have difficulty with traditional approaches to mathematics, with group therapy sessions for victims of "fraction phobia" and adventures of a "counter" spy in search of large numbers. And in Mississippi ETV's Weather Matrix, film clips transport students to storm fronts where they are present at the development of tornadoes and hurricanes, watch the storms in action and see the destruction left behind.

Only a single science series is designed for children to watch both at home and at school, 3-2-1 Contact produced by the Chidlren's Television Workshop. Like the programs designed just for in-school use, it was developed with the advice of experts—both academics and children. The academics recommended that the series focus on 8-12 year-olds, a time when children begin to develop a capacity for systematic cause-and-effect thinking and a critical period in the development of their attitudes toward science. Young children, especially girls and minorities, who too often see science as an unattractive field—dull and rigorous—provided guidance concerning what would be exciting and entertaining—programming which stressed human involvement in science, showed strong and competent role models and emphasized the children's interest in animals and the human body and the human implications of science and technology. the resulting programming responds to their interests and abilities; the young cast, with many girls and minorities, uses scientific reasoning to develop clues and draw conclusions as employees of the Bloodhound Gang detective agency. And they conduct interviews with working scientists, asking questions identified by the over 8,000 children who were consulted in the development of the program.

Just as 3-2-1 Contact helps develop the thinking skills of young children, KCET Los Angeles' Why in the World provides experiences in critical thinking and problem solving for the emerging adult population now in high school. The twice a week series was inspired by the concerns of Walter Cronkite, expressed in the 1980 annual conference of the National Association of Secondary School Principals:

> In an era of incredible technology and enormous opportunity we are not designing or delivering a relevant current events system to our children. We in the media are providing news and information. You in education are providing knowledge. Neither of us is consistently helping to pass on an understanding . . .

In order to fill the gap between the news and the educational curriculum we need a vehicle to intermesh current events with the other disciplines so that they become part of the entire teaching and learning experience.

The realization of this dream came with the collaboration of KCET and Satellite Educational Services, Inc., a non-profit organization formed by Water Cronkite. And it is directed at a problem in the adult world which is even more acute at the high school level. As Megatrends author John Naisbitt said, "We are drowning in information but starved for knowledge . . . Uncontrolled and unorganized information is no longer a resource . . . instead, it becomes the enemy . . ." With high school students who are segregated from the world of work and the course of human events, the information pollution problem is still more serious. Educators must consistently attempt to overcome the student sense of distance—the feeling that they have no effect on and are not affected by outside events. At the same time, educators are challenged to develop students' critical thinking skills so they can grapple with, analyze, synthesize and make valid and effective use of this mass of information which threatens to suffocate them.

Why in the World, the only television program which analyzes serious topics for the next generation of decision-makers, addresses these problems by simply encouraging students to ask why. Why in the World . . . should we care about what happens in Poland? . . . do some people avoid legal responsibility? . . . does Shakespeare help reveal the way terrorists think? . . . is science like a soap opera?—with program hosts ranging from Isaac Asimov and Senator John Glenn to Arthur Laffer and David Halberstam. And, according to teachers using the series, it is succeeding—sparking classroom discussions on cause and effect relationships and refining the students' ability to make critical observations of events, ideas and human behavior.

Our pride in our science programming is limited, however, because both the current amount and future development are limited. Of the over 150 series distributed by the Agency for Instructional Television (AIT), only 18 are science oriented and only 6 concern math skills. Moreover, most of the programming is limited to once a week series of 15 or 20 minutes each and the bulk of it is targetted at the elementary level. Only a very few courses have been designed for learners at the junior high level and there are virtually no courses specifically designed for the science and math needs of high school students. At a time when, nationwide, half of all newly-employed science and math teachers for the school year 1981–82 were unqualified to teach science or math, such programming at the high school level could make a vital contribution. Yet little is available because it is costly and difficult to produce, and funds to do so are not readily available.

Funding from the Department of Education for a variety of programs our stations have utilized in the past has been reduced by about 50 percent in the last two years. The Public Understanding of Science Program at the National Science Foundation, so critical to our nationwide science series, has been eliminated. And with a $42 million reduction in support for the Corporation for Public Broadcasting, our combined shortfall, at the federal level, is about $60 million. As this Committee is well aware, state and local governments and educational institutions are ill-equipped to make up these reductions, given the serve pressure on state and local educational budgets. While we can, and have, tightened our belts—reducing the number of hours stations broadcast, cutting back on salaries and number of employees, postponing the replacement of outdated equipment—the bulk of the cuts, we fear, must be borne by programming itself, because that, afterall, is what our equipment and employees collectively provide. Under the greatest pressure is that programming which traditionally has been the responsibility of government and educational institutions compared to the program more readily sustained by corporate and voluntary view support. This while our aim is to become a stronger partner in the solution, our concern is that, absent additional governmental support, we shall contribute even less.

This result would be as unfortunate as it is unnecessary because the program production and distribution capabilities of this nation's educational television system offer unique opportunities to implement plans for improvement in elementary and secondary science and mathematics education and a wide scale and in a cost-effective manner. Most important is our access to well over 90 percent of the U.S. population. Thus it is a service especially suited to providing college-level coursework to individuals without easy access to campuses, due to employment schedules, domestic demands or both, just as it has been well suited to providing instructional programming directly into our K-12 classrooms.

On the other hand, with some measure of additional support, creative constructive solutions are readily available.

Educational television can help overcome the shortage or qualified science and mathematics teachers in two-ways—be extending the reach of quality classroom teaching and by upgrading the skills of existing and potential teachers. Extending the reach of classroom teaching can be accomplished simply by the live broadcast of classroom teaching to those who do not have easy access to the classroom. In New Mexico, for example, small rural schools were faced with the threat of closing down because they could not attract certified teachers in specific disciplines. At the initiation of local school superintendents, KENW-TV, the public television station in Portales, began broadcasting courses in higher level math and computer science to classrooms as far as 100 miles away. Twenty-seven West Texas and New Mexico school districts now have access to these courses. In Arizona, the concept of a "microcampus" has been developed. Electronics plant employees working at eight plants in or near Phoenix will have access to 21 courses from Arizona State University's College of Engineering and Applied Sciences—which can lead to masters degrees in computer science, electrical engineering and industrial engineering—through live telecasts of courses made possible by KAET-TV via ITFS. A similar component of courses from the University of Arizona is provided by KUAT-TV in Tucson, also via ITFS, which not only serves business employees in the Tucson area but also members of our armed forces serving at Fort Huachuca, a major electronics installation of the U.S. Army. Eventually a statewide service is envisioned, connecting Northern Arizona University in Flagstaff as well as the Tucson and Phoenix services.

In South Carolina, where a similar program has been operating for close to a decade, the South Carolina ETV Commission provides live telecasts of University of South Carolina science and engineering courses via closed circuit to technical centers located throughout the state. Individuals throughout South Carolina can continue to work full time and have access to night classes from Columbia, interacting with the instructor through a two-way audio system. The success and appeal of this program is demonstrated by the fact that 65 percent of the graduate degrees conferred in the state are to these telecast students.

Many states provide inservice teacher training through broadcast or ITFS services. In Kentucky, all public universities and two independent colleges participate in the higher telecommunications consortium, organized to meet the needs of teachers experiencing hardship in completing the Master's program required for permanent certification. During the past decade, about 6,000 have enrolled in the Masters credit telecourses broadcast by Kentucky Educational Television's 16 transmitters. And, during the last eighteen months, inservice teacher training has been available nationwide, through the service of 237 public television stations. The courses broadcast, selected after excerpts of 37 potential courses were evaluated by stations, colleges and universities throughout the country, included four inservice teacher training courses and one biology course—all for college credit.

In addition, public television services can facilitate the introduction of new technologies into the classroom through interactive teletext, cable and videodisc. In the fall of 1981, KCET began a pilot project in five elementary schools in Southern California to supplement and complement the traditional school curriculum, by providing teachers with materials not typically available in the classroom. Working with advisors from the Regional Educational Television Advisory Council (RETAC) and the Los Angeles County Schools, KCET placed teletext decoders in five school where fourth, fifth and sixth grade teachers were afforded regular access to the teletext-equipped TV set. KCET project staff provided teachers with explanations of teletext, instructions on how to use it and suggestions for activities. After a one-year trial, and subsequent evaluation, teachers, students and administrators were all pleased. The teachers agreed that the teletext medium has a strong motivational influence for children. They also overcame their initial skepticism about classroom use of the program and projected that their colleagues who had not participated in the experiment would want to take part in any new effort. Particularly encouraging were the indications that students less well equipped to handle traditional math were motivated by the teletext experiment.

In San Diego, KPBS has just completed a pilot project testing the use of Cox Cable's "Indax" interactive cable technology in instruction. The keyboard allowed students to call up "electron class notes" and afforded instant access to a glossary and bibliography of course material. And in Lincoln, Nebraska, the ETV Network's "Videodisc Design/Production Group" which has been developing interactive videodisc instructional capabilities for the last four years, has become a center of videodisc designers to share information and technical expertise, a clearinghouse for information and a production center. One of its productions is "The Physics of Structure," a college physics course that offers individualized instruction.

Computer training courses for educators are envisioned in New York and Kentucky. In New York, WWET/Thirteen is exploring ways to expand the classroom computer-use workshops it now provides to area teachers. Specifically, it is investigating the possibility of establishing public television based resource centers which would serve teachers in their regions, providing comprehensive training in the use of technology for education and ongoing support and services to successfully integrate technology with other classroom activity. In combination with local workshops and leadership teleconferences, experiences in the purchasing of and teaching with new technologies can be shared and analyzed by a broad reach of school teachers, administrators and board members on a continuing basis in a cost-effective manner. In Kentucky, in response to a request of the Head of the Bureau of Instruction of the Kentucky Department of Education, the KET staff has brought together a task force to study how instructional television and micro-computers and available software as well as the need of administrators and teachers for inservice training to effectively utilize the technology. In addition, KET is currently in production on a television inservice series on the instructional applications of microcomputers which will be available next fall.

Finally, public television stations have a unique ability to extend the reach of coursework to the viewing public. At the request of area colleges, Washington, D.C.'s public television station WETA acquired an Introduction to Computers course entitled Making It Count, produced by the Boeing Company. In addition to the 375 students taking the courses for college credit, formal viewing opportunities have been made available at over 30 U.S. federal departments and agencies and over 25 area business and industry offices. Local sales of the $25 textbook accompanying the course exceed 2500—well over six times the number of students taking the course for credit.

In conclusion, public service television is one of the critical national resources available for a comprehensive, cost-effective contribution to this nation's need for science and math literacy and achievement. Yet it is under-utilized because it is underfunded. It has a proven track record of attracting the attention and interest of our young people whose achievement depends on additional motivation just as it has in increasing the expertise of the highly motivated graduate students. Just as importantly, it has a proven track record in attracting growing levels of financial support at the state and local level and from the corporate community. But this support will only be targetted at our needs in the areas of science, math and computer education if there is a substantial federal commitment. Without it, a unique opportunity to provide the maximum possible benefits at minimal expense, as quickly as possible, will be missed and America's most ambitious objectives will remain illusive.

PREPARED STATEMENT OF THE EDISON ELECTRIC INSTITUTE

The Edison Electric Institute appreciates the opportunity to submit testimony on H.R. 30, a bill to provide assistance to improve elementary, secondary and postsecondary education in mathematics and science, and for other purposes.

The Edison Electric Institute (EEI) is the association of America's investor-owned electric utility companies. Members provide 78 percent of the electricity in the United States today. EEI is recognized as the principal forum where electric utilities exchange information on every area of electric utility operation and concern as well as emerging technologies that are shaping the energy future.

We support the provision of the "Emergency Mathematics and Science Education Act," and find the following sections of particular importance. Section 604.5, the use of funds by local educational agencies, encouraging partnerships between "teachers, universities, the business sector, public agencies and other institutions, agencies and individuals." In this decade, it is imperative that educators have opportunities to become well informed about technological changes and utilize community resources that will challenge students to excellence in mathematics and science. In this area, the Edison Electric Institute and its member companies have been and will continue to be involved in activities that prepare students for societal changes. EEI recognizes that a high technology era requires new skills for individual employees and presents unprecedented career options for tomorrow's work-force.

The Edison Electric Institute views the Congressional Scholarship Program (Section 621) as one of the most effective incentives to attract new talent to the teaching profession in the area of mathematics and science. Critical industries like the electric utilities depend upon knowledgeable and talented teachers to prepare a work-force that is skilled and informed about the most advanced technology. It is hoped that this initiative will attract our most intelligent and creative young minds to the teaching profession.

The initiative (Sections 623 and 604A) which addresses the problems of mathematics and science teachers, administrators, and local school board members, is vital for today's educators. Staff development is one means for updating information about advances in technology and related area of mathematics and science. The Edison Electric Institute and its member companies have long provided support for institutes and workshops for elementry and secondary teachers. This new impetus from the federal level demonstrates an awareness on the part of leaders in this 98th Congress that problems must be confronted and alliances forged between education, business and governmental agencies. This activity must take place at the local level to achieve national goals. EEI and its member companies will continue to be partners in this effort.

EEI views Section 624, the proposal to conduct research and initiate development, as an integral component for the new thrust towards improving the quality of instruction in mathematics and science. It is critical to the long range impact of this program and to the restructuring of our economy, from heavy industry to information and service businesses. R&D efforts are critical to our nation's progress on an uncharted course to a new era.

We view the support of this Committee as one important force that will make it possible to improve productivity now and prepare a work-force for the knowledge industries. Your leadership in conducting these hearings is applauded by all who recognize the need for better scientific and technical training. We share the sense of urgency demonstrated by this "Emergency Mathematics and Science Act" and will cooperate to the fullest possible extent with its purposes.

NATIONAL CONFERENCE OF STATE LEGISLATURES,
Washington, D.C., February 1, 1983.

Hon. CARL PERKINS,
Chairman, Subcommittee on Elementary, Secondary and Vocational Education, Washington, D.C.

DEAR MR. PERKINS: As we were unable to testify on the Emergency Math and Science Education Act (HR30) in person, the National Conference of State Legislatures would like to submit this letter and the enclosed policy statement, "Special Programs to Fill Occupational Needs", for the record and for the general information of your subcommittee members.

The NCSL Committee on Education and job Training proposed this position statement, which was subsequently adopted by the NCSL membership, after much deliberation on the issue of the proper role of the federal government in the important area of Science and Math Education. The near unanimous thinking of the committee (composed of legislators of both political parties from all around the country) was that we would welcome a partnership role with the federal government in eliminating the shortage of mathematicians, scientists, and engineers now found in the country.

While saying this, however, we are mindful of two major facts: (1) it is the proper constitutional role of the states to deal with educational needs, and (2) many states presently are taking the initiative to deal with this very problem. But the states do need help with resources—not unlike the resources provided for years through state grants to fill a need in the area of vocational education. Providing federal startup funds to states through a national education program aimed at meeting future public and private needs in Science and Math would not only encourage states to do more, but help to coordinate federal and state efforts toward a more effective resolution of the problem.

We applaud your concern and interest in this important issue, and look forward to working with you in the development of an appropriate partnership between the states and the national government to enhance Science and Math Education in the United States. We would welcome any future opportunity to meet with you and your committee on this legislative initiative.

Sincerely,

WILHELMINA DELCO,
Chairman, Committee on Education and Job Training.

POLICY ON SPECIAL PROGRAMS TO FILL OCCUPATIONAL NEEDS—ADOPTED JULY 1982

NCSL has long been supportive of federal efforts to assure access and opportunity in both elementary-secondary and postsecondary education in the United States, feeling that this is an appropriate federal role in education in partnership with the states.

To further clarify that position, the NCSL Education and Labor Committee adopted a list of federal program priorities that are worthy of continued support. Among these are applied research; postsecondary student financial aid for low and moderate-income students; funds to assist the states in the education of the handicapped; compensatory education for disadvantaged students; refugee and entrant assistance, including program support for students with limited-English proficiency; migrant student assistance; Indian education; and vocational education, especially for disadvantaged students.

However, NCSL also has long supported the position that education is a primary constitutional responsibility of the states—not of the federal government. Policy decisions that determine what is taught and how it is taught are best left up to state and local officials who have first-hand knowledge of the needs of the state and its people.

Legislation is now being introduced in Congress which would insert the federal government into selective support for students who would choose to study mathematics and science either for the ultimate purpose of teaching these subjects or to fill the technological needs of industry for both civilian and military purposes. While NCSL recognizes the national need for more mathematicians and scientists in industry and education, we do not think it is appropriate for the federal government to be setting the educational agenda for the nation.

Therefore, NCSL opposes any attempt on the part of the federal government to preempt the states' constitutional role in determining educational policy for enhancing specific occupational areas.

Also, NCSL reaffirms its support of the consultative role of state and local officials through the office of the Under Secretary of Education and the Intergovernmental Advisory council on Education in the process of developing, administering and regulating federal education programs.

CAPE,
Washington, D.C., January 26, 1983.

Hon. CARL PERKINS,
Rayburn House Office Building,
Washington, D.C.

DEAR CONGRESSMAN PERKINS: The Council for American Private Education (CAPE) has decided, with a great deal of reluctance, not to offer oral testimony at your hearings on January 26–27 on the Emergency Math-Science Education Act, H.R. 30. We applaud your leadership toward finding a good set of approaches to the crisis this country faces in math-science teaching and learning. And we are deeply appreciative of your awareness, as reflected in the legislation, that private school teachers and students are heavily involved in the national circumstances of math-science education which are propelling searches for solutions.

I previously sent in testimony which reflected the general views of private education on various bills before the House. The major observations they contained were these:

1. For all educators to continually encourage growing girls to perceive themselves as equally able, if not more so than boys, to "do" math and science and to consider careers that centrally involve them.

2. To encourage cooperative arrangements in every community between government, industry, public and private (and higher education where present) to develop

local technological centers or laboratories for students and adults. Technological literacy is expensive and no single education entity can afford the equipment and personnel needed to gain it on a wide-scale basis.

3. Funding shoulc be made available for in-service training of teachers in public and private schools.

4. Low-cost loans with forgiveness incentives should be made available to college students intending to pursue math-science teaching careers.

5. Industry should be encouraged, via tax incentives, to assist via gifts of hardware to schools, to loan personnel to schools to teach and give in-service training and to hire teachers in the summer for work experience and to supplement income.

6. To utilize senior citizens who can do so to teach math-science on a temporary basis.

I am currently collecting the thoughts of my constituency toward sending you a more updated rendering. As soon as I hear back more from our member organizations, I will send you a set of thoughts for the record of your January 26–27 hearings.

It's a very tough issue, one in which the very workings of our technological society connects directly and with fateful consequences with the substance of what's taught and how it's taught in the schools.

We need the best thinking applied to it we can find.

I hope we can help provide some of that when I send in our more official testimony.

Again, our profound thanks for your leadership in this matter.

Very sincerely,

Robert L. Smith,
Executive Director.

Commonwealth of Puerto Rico,
Hato Rey, Puerto Rico, February 4, 1983.

Hon. Carl D. Perkins,
House of Representatives,
Washington, D.C.

Dear Chairman Perkins: It is with great pleasure that I submit the enclosed statement in support of the proposed Emergency Mathematics and Science Education Act (H.R. 30). I ask that this written statement be included in the record of hearings which the committee recently held concerning this important legislation.

In my view, H.R. 30 represents a thoughtful approach to the critical national need to improve the quality of science and mathematics education at the elementary and secondary levels. As is discussed in the enclosed statement, Puerto Rico has an acute shortage of trained and qualified teachers of science and mathematics. In addition, we have an urgent need to upgrade the equipment that is used to teach these subjects. Although the Commonwealth of Puerto Rico currently spends more than one-third of its budget on education, we will not be able to effectively address these severe problems concerning the quality of instruction in science and mathematics without substantial Federal support. In this regard, I am extremely gratified that H.R. 30 provides for equitable participation by Puerto Rico.

For the reasons set forth in the enclosed statement, I believe that the effectiveness of H.R. 30 would be enhanced if it were amended to: (a) reserve a larger proportion of the funds to support activities, such as inservice training and summer institutes, at the State level; (b) eliminate the provision that calls for the U.S. Secretary of Education to develop criteria for distributing 25 percent of the funds among local school districts; (c) give State educational agencies the specific authority to coordinate Federal funds with State funds; (d) authorize State educational agencies to develop and conduct (or contract for) projects to train or retrain teachers and administrators; (e) authorize and encourage States to increase coordination and cooperation among the various levels of government, postsecondary education and private industry; and (f) authorize the use of funds to purchase texts, library resources and equipment (including computer hardware and software). In my view, this legislation will be most effective if States are given the flexibility to address this major national problem in the context of their unique local needs.

In summary, I commend the members of the committee for the wisdom and foresight which is reflected in H.R. 30. It is my hope that the Congress will soon enact legislation to reverse the decline in the quality of instruction in science and mathematics. In this era of increasing emphasis on high technology and automation, I truly believe that our national security and economic well-being depend upon the development of a workforce that is literate in science and mathematics. If Puerto Rico is to continue to serve as a successful example of free-enterprise and democracy in the Caribbean region, we must adequately train our young people in the science, mathematics and technological subjects.

In closing, I wish to express my appreciation for the leadership that you have provided in approaching this subject. You are most welcome, at any time, to visit our elementary and secondary schools in Puerto Rico and observe first-hand the critical need to upgrade our instructional programs in science and mathematics. I would, of course, be glad to provide any additional information that may assist the committee in its deliberations.

Cordially,

MARÍ SOCORRO LACOT,
Secretary of Education.

Enclosure.

STATEMENT OF DR. MARIA SOCORRO LACOT

INTRODUCTION

I am pleased, as the Puerto Rico Secretary of Education to submit this statement in support of the proposed Emergency Mathematics and Science Education Act (H.R. 30). As many others have accurately observed, our nation's productivity, national security and economic well-being are seriously threatened by the current crisis in science and mathematics education. As discussed below, federal assistance is badly needed to improve the quality of science and mathematics instruction at the elementary and secondary levels.

There is a national need to improve science and mathematics education: During recent years, much of America's economic growth has occurred in the high technology industries. It is obvious that this trend toward high technology, automation and miniturization will only accelerate in the years ahead. The Congressional Budget Office has projected that new technologies will make (3) million additional jobs obsolete by the end of this century. Yet, despite the rapidly increasing demand for a more highly trained workforce, our educational system is failing to deliver adequate instruction in science and mathematics.

Numerous studies have documented the decline of student achievement in mathematics and science. Average science and mathematics scores on standardized college entrance examinations have been steadily dropping for the past twenty (20) years.

This decline is not surprising when one considers that secondary students are taking fewer courses in mathematics and science than in past years, and fewer courses are being offered. Although half of all high school students in the United States take no mathematics after the tenth grade, other industrialized nations, particularly Japan and Germany, are placing increasing emphasis on science and mathematics education.

One of the major causes of the decline in the quality of education in science and mathematics is the shortage of qualified mathematics and science teachers. During the 1970's the number of secondary school mathematics teachers being trained declined by 77 percent and the number of science teachers being trained declined by 65 percent. It has been estimated that about 50 percent of all newly employed teachers nationwide are uncertified and unqualified to teach mathematics and science. This situation is exacerbated by the departure of trained classroom teachers for better paying jobs in industry. Recent statistics released by the National Science Foundation indicate that, nationwide, 16 percent of all elementary school teachers are not sufficiently prepared to provide basic training in science and mathematics.

Puerto Rico has an acute need for trained teachers of science and mathematics: As is generally the case throughout the nation, Puerto Rico lacks the qualified teachers and equipment needed to provide elementary and secondary students with adequate instruction in science and mathematics.

The impact of our inability to provide basic training in these subjects is obvious when one considers the size of the educational system in Puerto Rico. As one of the largest local educational agencies in the United States, the Puerto Rico Department of Education (PRDE) presently serves over 710,000 students in kindergarten through twelfth grade. About 130,000 of these students attend high school. The PRDE currently employs about 35,000 teachers to provide instruction in the academic subjects.

In keeping with the situation in most States, achievement tests which were administered to students in Puerto Rico's elementary and secondary schools during the past two years have revealed lagging student achievement in science and mathematics, particularly in the subjects of physics and mathematics. For example, the results of a physics test recently administered to a sample of 150 students from public and private high schools revealed that one-half of the students who took the test correctly answered 37 percent (or more) of the questions regarding mechanics and 36 percent (or more) of the questions on "electricity." Those results are extremely low in view of the fact that a 70 percent level of accuracy was the anticipated normal performance level.

The results of a test that the College Board of Puerto Rico Advanced Placement Program administered last year to talented students and those interested in scientific subjects are perhaps even more distressing. The test results showed that:

(a) Only 46.3 percent of the 240 students who took the test on biological sciences achieved a passing score; and

(b) Only 49 percent of the 236 students who took the test on physical sciences achieved a passing score.

These results are particularly disturbing when one considers the type of student who participated in this program. As elsewhere, a major cause of the unsatisfactory level of achievement in science and mathematics in Puerto Rico is the inadequate academic preparation of teachers in those subject areas.

During the 1981–82 school year, the PRDE employed 9,800 science teachers at the elementary level, 913 at the junior high school level and 755 at the high school level. A recent study that was conducted using a sample of those teachers produced the following results:

Elementary school teachers.—Of the 5,137 elementary school science teachers who participated in the study: 30.3 percent had no college credits in science; 37 percent from one to six credits; 8.8 percent from 7 to 10 credits; 19.6 percent from 11 to 20 credits; 2.9 percent from 21 to 30 credits; 1 percent from 31 to 40 credits; and 0.23 percent had 41 credits or more. In other words, over two-thirds of the elementary school science teachers had six or less college credits in science.

Junior high school teachers.—Of the 741 junior high school teachers who participated in the study: 2.15 percent had no college credits in biology; 10.12 percent had from 1 to 10 credits; 21.59 percent had from 11 to 20 credits; 26.72 percent from 21 to 30 credits; and 39.40 percent had from 31 to 50 credits.

Of the same sample: 19.43 percent had no college credits in the field of chemistry; 43.04 percent had from 1 to 10 credits; 29.24 had from 11 to 20 credits; 6.20 percent from 21 to 30; and 2.15 had from 31 to 50 credits.

Of the same sample: 23.48 percent had no college credits in physics; 53.73 percent had from 1 to 10 credits; 19.43 percent had from 11 to 20; 0.94 percent had from 21 to 30; and 0.40 had from 31 to 50 credits.

High school teachers.—Of the 548 high school science teachers who participated in the study: 2.91 percent had no college credits in biology; 6.02 percent had from 1 to 10 credits; 15.14 percent had from 11 to 20 credits; 9.48 percent had from 21 to 30 credits; and 5.10 percent had from 31 to 50 credits.

Of the same sample: 16.42 percent had no college credits in chemistry; 35.58 percent had from 1 to 10 credits; 33.39 percent from 11 to 20 credits; 9.48 from 21 to 30 credits; and 5.10 percent from 31 to 50 credits.

Of the same sample: 23.17 percent had no college credits in physics; 47.08 percent had from 1 to 10 credits; 22.99 percent had from 11 to 20 credits; 4.74 percent had from 21 to 30 credits; and 2 percent had from 31 to 50 credits.

In summary, this study clearly documents that our science teachers lack adequate academic preparation. The study further indicates that most science teachers have taken more college courses in the biological sciences that in the physical sciences. In my view, this lack of preparation translates directly into low student achievement levels.

Properly trained teachers are especially needed to provide students with the knowledge demanded by high technology industries. In particular, improved insturction is necessary to enable students to master the skills required by the electrical and electronic computing industry. Although recent profiles prepared by the Puerto Rico Economic Development Administration indicate that much of Puerto Rico's recent economic growth has occurred in the high technology, pharmaceutical, and electronic industries, our science teachers are most deficient in the academic preparation needed to effectively teach subjects (such as chemistry, mathematics and physics) which relate to those industries.

Some efforts have been made to address this problem in Puerto Rico. For example, in-service programs are presently being operated by the University of Puerto Rico's Resource Center for Science and Engineering and the Puerto Rico Science Teachers' Association. Although these efforts have resulted in some improvement in the qualifications of science teachers in Puerto Rico, our limited resources have enabled only a small number of teachers to participate in the training.

In addition to having an acute shortage of trained and qualified teachers of mathematics and science, Puerto Rico has an urgent need to upgrade the equipment that is used to teach these subjects. Although we recognize this need, we lack the resources that are needed to remedy the situation.

Federal action is required to effectively address the critical need to improve the quality of instruction in science and mathematics: As discussed above, our national security and economic future depend to a considerable extent on how well we meet the challenge of training and retraining America's workforce to compete in the age of high technology. The problem of inadequate instruction in science and mathematics is not limited to certain States or regions; it is rather, a major national problem. Throughout the country, there are too few qualified teachers and too little modern equipment to provide adequate instruction in science, mathematics and other technological subjects.

Although most States are making efforts to improve the quality of instruction in science and mathematics, significant improvement on a national level will not occur without substantial federal financial support. State and local educational agencies simply do not have the resources needed to meet this challenge.

Despite the fact that the Commonwealth of Puerto Rico currently spends more than one-third of its budget on education, we—like most States—will not be able to effectively upgrade the quality of our science and mathematics teachers without substantial federal support. In this regard, I am gratified that H.R. 30 provides for equitable participation by Puerto Rico.

I recognize the need for fiscal restraint and support a prudent approach to federal spending. However, if the Congress fails to appropriate substantial funding to address the serious problem of declining student achievement in mathematics and science, it will be jeopardizing our economic well-being and future defense capability. Numerous reports have commented on the difficulties that our armed forces face in training enlistees to operate and service today's increasingly sophisticated military hardware. This serious national security problem is due to inadequate instruction in our elementary and secondary schools.

As President Reagan accurately recognized in a message to the 1982 National Academy of Sciences Convocation on Science and Mathematics in the Schools:

"The problems today in elementary and secondary school science and mathematics education are serious—serious enough to compromise America's future ability to develop and advance our traditional industrial base to compete in international market places."

The proposed Emergency Mathematics and Science Education Act (H.R. 30) reflects a thoughtful approach to the problem: In my view, H.R. 30 would effectively address the critical national need to improve the quality of science and mathematics education at the elementary and secondary levels. I strongly support the legislation which, if adequately funded, would provide the resources needed to attract, train and retrain science and mathematics teachers.

The effectiveness of H.R. 30 would be enhanced by increasing the flexibility of States to address this national problem in the context of local needs and by authorizing the use of funds to purchase texts, library resources, and equipment: Although I strongly support the passage of H.R. 30, I believe that this legislation would be even more effective if States are given greater flexibility to address this major national problem in the context of their local needs.

More specifically, I believe that the effectiveness of H.R. 30 would be enhanced if it were amended as follows:

a) Reserve a larger proportion of the funds to support activities such as in-service training and summer institutes at the State level. Summer institutes have been shown to be one of the most effective ways to improve the qualifications of teachers. In my view, such institutes, as well as other forms of intensive inservice training in science and mathematics, could be arranged and coordinated most effectively at the State level.

b) Eliminate the provision that calls for the U.S. Secretary of Education to develop criteria for distributing 25 percent of the funds among local school districts. Because of the significant variations in needs and priorities, the decision as to how to best target the funds should be made at the State level.

c) Give State educational agencies the specific authority to coordinate Federal funds with State funds. In order to avoid a duplication of effort and maximize the impact, States should have the authority to coordinate Federal funds with State programs.

d) Authorize State educational agencies to develop and conduct (or contract for) projects to train or retrain teachers and administrators. State educational agencies have the capability to establish innovative programs to train and retrain teachers and should be authorized—indeed encouraged—to do so. In order to assure quality and relevant, it would be best to require that all inservice training under this program be approved by the State educational agency.

e) Authorize and encourage States to increase coordination and cooperation among the various levels of government, postsecondary education and private industry. In my view, efforts to deal with this problem will be most successful if State educational agencies, institutions of higher education, local educational agencies and the private sector cooperate. State educational agencies should be authorized to facilitate such coordination of effort.

f) Authorize the use of funds to purchase texts, library resources and equipment (including computer hardware and software). In order to give students an adequate education in science, teachers must be provided with up-to-date texts, library resources and equipment. Presently, many schools lack the resources required to acquire the basic texts and equipment needed to facilitate science education. Therefore, I urge that H.R. 30 be amended to permit the use of funds to meet this pressing need.

CONCLUSION

In summary, I commend the members of the committee for the wisdom and foresight which is reflected in H.R. 30. It is my hope that the Congress will act quickly and dramatically to reverse the decline in the quality of instruction in science and mathematics.

In this era of increasing emphasis on high technology and automation, I truly believe that our economic future depends upon the development of a work force that is literate in science and mathematics. Similarly, if Puerto Rico is to continue to serve as a successful example of free-enterprise and democracy in the Caribbean region, we must adequately train our young people in science, mathematics and technology. As the committee recognizes, Puerto Rico—like most States—will not be able to effectively meet this challenge without substantial Federal assistance.

I would, of course, be most willing to provide any additional information that may assist the Committee in its deliberations concerning this important subject of national concern.

American Chemical Society,
Washington, D.C., February 9, 1983.

Hon. Carl D. Perkins,
Chairman, Committee on Education and Labor,
Washington, D.C.

Dear Congressman Perkins: The American Chemical Society is a congressionally chartered non-profit scientific and educational organization of more than 126,000 chemists and chemical engineers. Our membership includes high school chemistry teachers and administrators, educators and researchers at colleges and universities, and scientists and engineers in the government and industry.

The Society is engaged in a broad array of chemical education activities from the precollege to graduate levels, including technician training and continuing education. While our commitment to the high school community goes at least as far back as 1922, the Society has stepped up considerably its efforts in this area in the past five years. This new thrust is described in detail in the attached document.

We believe that the nationwide crisis in the teaching of science and mathematics to precollege students has reached such proportions that a Federal initiative clearly is needed. The Federal role should be to create the climate and provide the critical resources for initiating a sustained, long-term national commitment to bring mathematics and science education to young people of this country to enable them to lead productive lives in our high technology society, and to contribute to its maintenance and growth.

In defining and implementing the Federal role, we believe that it is important to recognize the contributions that both the National Science Foundation and the Department of Education can make. It is of the greatest importance that the resources of these agencies are brought to bear on the problem in a concerted effort that is both effective and efficient.

We believe that the following principles should govern Federal involvement in science, math, and engineering education from the precollege through post-graduate years.

1. There must be a firmly established, explicit Federal policy aiming for high quality education in science, math, and engineering at all levels.

2. Federal support should be distributed as follows: Precollege programs (approximately 45 percent); Higher education programs (excluding graduate research) (approximately 45 percent); and Research, analysis, and information brokering (approximately 10 percent).

3. Separate programs within each of the above areas should be carefully focused and coordinated.

4. Cooperative efforts should be fostered to the greatest extent possible among the National Science Foundation, the Department of Education, local and State education bodies, colleges and universities, businesses, industry, and other relevant institutions.

5. For programs to be successful and efficient, the Federal Government should serve as an "information broker," so the results of projects are widely disseminated, especially to those teachers preparing proposals for support of related efforts.

6. The precollege and higher education programs should be content-oriented, and should focus on direct and indirect support for teacher development and curriculum improvement.

7. At the precollege level, the Federal role should be to encourage excellence in teacher education, certification, and recertification, and development of relevant instructional materials. Subject-matter specialists should assume a major role and responsibility for inservice education programs at Federal, State, and local levels to provide for professional growth of science teachers and for the development of science cirricula.

8. External review panels composed of knowledgeable academic and non-academic scientists, mathematicians, and engineers should be convened regularly to assess programs and recommend modification, continuation, or termination.

9. Federal support should help colleges and universities keep their instrumentation, curricula, and faculty up-to-date. Critical problems these institutions face are the lack of, or obsolescence of, instrumentation for use in instruction, and faculty not having time for working on creative improvement of curricula and for personal professional growth.

The ACS Committee on Chemical Education has not had enough time for a thoughtful assessment of the programs proposed in H.R. 30, and certainly not those in the bill just introduced, H.R. 1310. We concluded from a preliminary analysis of H.R. 30 that its thrust is generally in accord with the principles we believe are crucial to improving science and math education at the precollege level. The Society, therefore, is supportive of the goals of H.R. 30. With the introduction of H.R. 1310, we will focus our attention on it, rather than H.R. 30. We expect to forward detailed comments to congressional committees in the very near future. In the meantime, there are four points we would like to raise:

(1) A federal role in information brokering must be specified to avoid wasting funds in duplicative efforts at the local level. Often the results—both positive and negative—of science education projects are not widely shared and this leads to a tendency to reinvent the wheel. The federal government should take a more active role in information dissemination.

(2) There must be incentives for a local commitment to solving problems in science and math education. For instance, requiring that certain federal funds be matched with non-federal support will necessarily bring into play more institutions at the local level. The general public, especially parents, as well as public and private institutions at both the state and local levels must take part in a campaign to improve the quality of precollege education in science and mathematics.

(3) The resources of scientific professional societies should not be overlooked. These organizations, including the ACS, constitute an enormous pool of talent and expertise that should be tapped for curriculum development, and for upgrading the education of precollege science teachers. Most of these societies have education divisions that would welcome the opportunity to play a greater role.

(4) Mechanisms must be established to ensure that research scientists from both academia and industry, and educators work together in full partnership. For example, federal support should be given to workshops which bring together precollege science and math teachers with scientists and engineers from their local colleges, universities, and industries to tackle limited, specific, curricular issues of importance to the local community. Another example is the formation of local and regional associations to work on curriculum improvement and teacher development. Finally, scientists must be given an opportunity to contribute to the public decision-making processes at the local and state levels which affect science and math education.

The ACS has made a considerable investment of its resources to improve and maintain the quality of chemical education from the elementary through the graduate levels. We offer the resources of the Society to the Committee and its taff for consultation.

Sincerely,

FRED BASOLO.

Mr. Chairman and Members of the Committee: I'm writing in support of your effort to provide an adequate level of funds for science education. It is vitally important for this country to undertake long term support of science, math and technology education for children. In particular, I would like to focus upon the role of broadcast television in helping address this issue and to tell you about CIW's experiences with 3-2-1 CONTACT, our television series on science and technology for elementary schoolers.

America is falling behind other countries in science and technology. America's economic leadership rests on science and technology. But the hard fact is that these fields are not very appealing to America's young people. The negative attitudes translate over time into pools of profesional talent inadequate to a technological age, and no less important, a general population which is scientifically illiterate ever though it will be called upon to make critical choices about the uses of science and technology—from nuclear to genetic engineering.

The problems of not enough students electing to pursue higher education in science and math do not spring full-blown at the high school or college level. They start at the elementary grades, where teachers are least prepared to teach science, and where states are least rigorous in setting standards for science curriculum and for certification of science teachers.

As President Reagan said in his State of the Union message, "If a child does not receive adequate math and science teaching by the age of 16, he or she has lost the chance to be a scientist or engineer."

Adding to this bleak picture is the plight of school budgets. Faced with tighter and tighter budgets, they are compelled to cut their education programs, and give an even lower priority to science—because it is not considered an educational "basic." Well science is basic to our lives—and getting more so very day.

Although the level of factual knowledge is a problem, even more baisc is the attitudinal problem, the need to get kids "turned on " to science—the critical target age range for doing this is eight to twelve. This is the goal and the target audience of 3-2-1 CONTACT, a national effort in place that deals successfully with the problem for this age range.

Television is a pervasive and powerful educational medium and can and should play an important role in science education.

3-2-1 CONTACT combines impact in the home, the school, and in special assemblages of children, such as the Girl Scouts; it reaches children and their families inexpensively. In the premiere run alone, there were more than 23 million home viewers. As for school usage, more than 500,000 teachers' guides have been requested and distributed. Cooperative work with the Girl Scouts of America has opened up new merit badge programs that specifically use 3-2-1 CONTACT as source material. In Washington, D.C. alone, over 10,000 merit badges associated with 3-2-1 CONTACT have been awarded to Girl Scouts. Large audiences in homes and schools reduce costs per program exposure as well. With repeat broadcasts of the series, it is reasonable to estimate the cost of reaching one person one time with one program from Season I at a penny. Such is the cost effectiveness of the television medium, programmed creatively.

3-2-1 CONTACT is widely used in classrooms as well. We offer free teachers guides and teachers training workshops in how to incorpatate educational television. Over a two-year period, 3-2-1 CONTACT outreach staff directly reached 60,000 elementary school teachers in over 450 training workshops. This kind of effort is a valuable extra tool for teachers to have available, and our efforts in this area should be continued and expanded.

With major funding from the National science Foundation, the Department of Education, and the Corporation for Public Broadcasting, we are now in the production of a second season of 3-2-1 CONTACT programs. For two years after the completion of the first season, we unsuccessfully sought renewal of corporate funding for this second season. The reduced funding means that we could not do a complete series of 65 programs, but only 40.

This points to the fact that federal funds have to be the major source of educational efforts in this area. What our nation's children need are not one-shot approaches to problems that were years in the making, but sustained, stable funding for effective television programming. The popularity and effectiveness of 3-2-1 CONTACT has already been demonstrated and I believe that we should continue to build on this solid base by producing additional 3-2-1 CONTACT series.

A commitment of $35 million over the next six years would enable production of three 65-program series. New programs will provide a continuing presence in the home and school for children; retain an adudince with new material (rather than constantly repeating our first 2 seasons); establish a widerbased audience; keep abreast of the latest scientific and technological issues; and report on new developments in the field.

Both in its own right for children and also for its later contribution to solutions at the high school and college levels, such funding would be an investment not only as a supplement to science education programs in the schools, but as a nationally known and available educational resource, also speaking directly to millions of children in their homes.

The federal government stands as the only funding source related directly to science and technology, and our own experience is that without a central source with specific and dedicated interest, it is difficult to get focused momentum going in any area. I applaud your efforts and concern in what I believe is a critically important field.

JOAN GANZ COONEY,
President, Children's Television Workshop.

ASSOCIATION OF RESEARCH LIBRARIES,
Washington, D.C., February 9, 1983.

Hon. CARL PERKINS,
Chairman, Subcommittee on Elementary, Secondary, and Vocational Education, Washington, D.C.

DEAR REPRESENTATIVE PERKINS: On behalf of the more than 100 major research libraries which are members of the Association of Research Libraries (ARL), I write to support the Emergency Mathematics and Science Education Act (H.R. 30). The Association shares the concern of the Congress about the state of mathematics, science, and technological education in the United States; and we consider H.R. 30 to be a reasonable approach to improving the current deficiencies in this area of our educational enterprise. We would like to have this letter added to the written record of testimony presented on the bill.

In order to effect real improvements in science education, we suggest that attention be given in the bill to the provision of supportive library resources, both material and human, that are up-to-date and available in the most useful and appropriate technological formats. Upgrading of these resources should take place at every level in the educational system from elementary through post-graduate institutions, and should include public library resources that support adult as well as pre-adult learning for Americans.

The area of post-secondary education is the particular responsibility of ARL's member institutions. In university libraries particularly, the continuing revolution in scientific and technological information has resulted in an explosion in the literature. The need of students and researchers to keep up with new information is so pressing, and the number of references to the literature in the many specialized fields of science is so large, that computerized databases are the only feasible tools for gaining access to the literature. Online searching of databases has replaced lengthy manual searching of printed indexes and abstracts as the accepted method of doing bibliographic research in these disciplines. Thousands of entries can be searched for needed citations efficiently and effectively using online search techniques. In addition, many new databases have become available that provide scientific data rather than citations; and these are also valuable research tools. Each use of these databases requires the payment of a fee based on the amount of time used on-line plus telecommunications charges.

Using these new technologies for the retrieval of scientific information requires that faculty and students receive training in the retrieval of information. Logically, this training should come from science librarians, who are the professional workers in the field of science information. Unfortunately, there is a severe shortage of librarians with scientific backgrounds. Recruitment to this specialty of librarianship suffers particularly from the fact that scientific salaries are much higher in the for-profit sector than in education-related enterprises. We support the suggestions made by the American Library Association in testimony before your committees to train library and information professionals so that they can work effectively with scientists and students of science.

We also urge you to consider specific language in H.R. 30 that would ensure that informational materials in the sciences, particularly journals and other serially-published materials, are made available to students and faculty through the libraries of their educational institutions. Scientific publications are the most expensive of all library materials and the cost of these materials continues to rise at a rate considerably higher than the rate of inflation. Yet the nature of science mandates that the latest information available is likely to be the most important to a researcher.

In conclusion, ARL wishes to thank the subcommittee members and staff for this important effort to resolve the critical situation in science education. It is our hope that the final version of H.R. 30 will recognize fully the importance of library and information resources and services to the success of the effort.

Very truly yours,

Shirley Echelman,
Executive Director.

NAESP,
Reston, Va., February 28, 1983.

Hon. Carl D. Perkins,
Rayburn House Office Building,
Washington, D.C.

Dear Mr. Perkins: The National Association of Elementary School Principals wishes to express its appreciation to Chairman Carl Perkins, first, for developing and introducing H.R. 30, the Emergency Mathematics and Science Education Act, and second, for providing in its context, a means of addressing the several components of this crucial issue. Beyond the considerable rhetoric engendered over mathematics and science education in relation to foreign economic competition, the basic concern for a literate society requires increased emphasis on sound instruction, improvement in the knowledge and capabilities of teachers, and a comprehensive understanding of the new management skills necessary to accomplish greater student learning.

First of all, let us convey our pleasure with the inclusion of the elementary school level in the bill. The understanding shown by this inclusion is exceptional. That children form their foundations of interests and attitudes toward mathematics and science at the elementary school level went practically unrecognized in the vast array of proposals submitted to the 97th Congress. Section 601 of this proposal insures that rightful recognition is intended to be given to the important beginning years of a child's schooling.

It is also particularly pleasing that a provision is included for in-service training for administrative personnel (Sec. 604(a)(1)(b)). Too often in the past, those who bore the responsibility for directing a program toward achieving the aspirations of its creators were ignored or overlooked in the authorization of the support systems so necessary to the program's success.

Because of confusion that might result in the interpretation of "supervisors of mathematics and science programs" in Section 623—Summer Institutes, we would propose that the word "principals" be inserted following the word "teachers". This, we feel, would clarify the opportunity for principals to join with teachers in a school building team approach to strengthening their skills in improving science and mathematics programs in their schools. This more unified direction has proven extremely beneficial in fostering improvements in educational service-delivery. The partnership that results from shared training and shared commitment to a strengthened program has consistently demonstrated a lasting positive effect on student learning and continued professional development of staff.

If such an inclusion would be deemed inappropriate, we would greatly appreciate report language that would assure us that the term "supervisors" is inclusive of elementary school principals. Such phrasing as "all those who supervise mathematics and science instruction" is suggested for your consideration.

We regret our inability to be present during the several days of hearings in January, and, therefore, are incorporating the essence of our recommendations in this letter. You can be assured of the Association's continued interest in and support for H.R. 30. Again we thank you for your effective leadership in its development and, we hope, eventual adoption.

Sincerely yours,

Edward P. Keller,
Deputy Executive Director.

American Psychological Association,
Washington, D.C., February 2, 1983.

Hon. Carl D. Perkins,
Committee on Education and Labor,
Washington, D.C.

Dear Chairman Perkins: We are writing on behalf of the 60,000 members of the American Psychological Association and the Association for the Advancement of Psychology regarding science and mathematics education. As the Education and Labor Committee prepares to consider H.R. 30, the Emergency Mathematics and Science Education Act, we want to alert you to two specific concerns: (1) support for education research as set forth in Section 624; and (2) an amendment proposed by Rep. Williams to establish public information programs.

EDUCATIONAL RESEARCH AMENDMENT

We commend the Committee for recognizing in Section 624 the important contribution that research relevant to education makes in efforts to improve the quality of mathematics and science education.

Section 624 is essential for the improvement and strengthening of mathematics and science programs. Research on the nature and processes of learning in these areas have significantly increased our knowledge and capacity to design effective education programs for American students.

The value of such research is well-documented in testimony presented to your Committee on January 31, 1983, by Dr. James Greeno.

As Dr. Greeno stated in his testimony:

"The focus of research studies on mathematics and science instruction will help us blend the need to learn substantive knowledge with effective instructional strategies. In past efforts, either too much emphasis was placed on providing teachers with new mathematics and science information—to the neglect of realistic ways to assist students in real classroom situations—or too much focus was placed on teaching process concerns—to the neglect of important substantive curricular needs. Recent improvements in research will allow the research authorized in H.R. 30 to promote an appropriate mix of process and substance and their application to: instructional materials; teacher training programs; school-site instructional improvement; secondary school math and science programs; advances in technological literacy and the appropriate and effective instructional uses of information technologies."

Therefore, we urge you to lend your full support to strengthening educational research and development by approving Section 624 at the proposed level of funding authorized in this Section.

PUBLIC INFORMATION PROGRAMS

We also urge that you support an amendment to H.R. 30 that has been offered by your colleague, Mr. Williams of Montana. We join with many other professional organizations in supporting this proposal, which would establish jointly-funded Public Information Programs. These programs, as set forth in the amendment, "are designed to educate the public about the role of science and mathematics in contemporary society, especially with respect to explaining the relationship between mathematics and science-based activities and the technological and economic development of the United States."

We believe public information programs are essential to efforts aimed toward improving the status of mathematics and science education. Without the full support of the American public regarding the importance of mathematics and science, legislative and educational efforts will be hindered. We further acknowledge the need for shared responsibility between the public and private sector, and endorse the approach taken in this amendment.

In summary, we are asking you, as a member of the House Education and Labor Committee, to support the following recommendations with regard to H.R. 30:

Retain Section 624, to strengthen educational research and development.

Approve the Williams amendment to establish Public Information Programs.

Please do not hesitate to contact us if we can be of assistance on these matters.

Sincerely,

Michael S. Pallak, Ph. D.,
Executive Officer,
Clarence J. Martin,
Executive Director and General Counsel.

INDIANA UNIVERSITY,
Bloomington, Ind., February 1, 1983.

Hon. CARL D. PERKINS
Chairman, Committee on Education and Labor,
Washington, D.C.

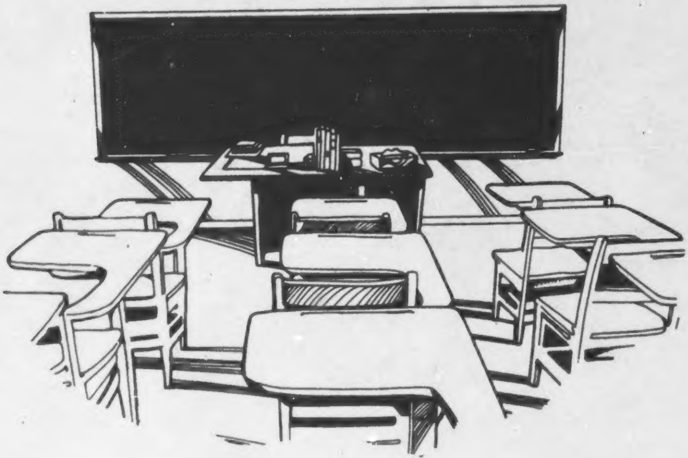
DEAR CHAIRMAN PERKINS: I am aware that your committee is in the process of holding hearings on H.R. 30, the "Emergency Mathematics and Science Education Act." The crisis facing mathematics and science instruction is understood very well in Indiana. Members of your committee might be interested to know that on October 19, 1982, we held a conference at Indiana University, Bloomington on what can and should be done to improve science and mathematics instruction in Indiana elementary and secondary schools. More than 300 persons from all parts of the state attended the conference; they heard speakers from government, business, labor, the schools and higher education explain how the problem affected them and what should be done. Partly as a result of this conference, the Indiana General Assembly has introduced two bills in an effort to partially remediate the situation. House Bill 1506 will provide loans or grants to existing teachers who seek additional certification as science and mathematics teachers and Senate Bill 404 provides "forgiveable loans" to undergraduates who choose careers as science and math teachers. The funding will be small in each case, hardly surprising given the financial condition of our state; but it is a step in the right direction. Furthermore, the Commission on General Education is now considering a proposal to double the number of credits in sciences and mathematics to be required for high school graduation. While this is a long-needed step, it will surely exacerbate the shortage of math and science teachers in our state.

I have enclosed a copy of the report of our October conference because we believe the recommendations are significant not only for Indiana but for the nation as a whole. I ask that the conference report be included in the hearing record being complied on H.R. 30 "Emergency Mathematics and Science Act." I would be pleased to meet with you or your staff at your convenience, to provide further information, or help in any other way this important undertaking.

Sincerely yours,

HOWARD MEHLINGER, *Dean.*

Facing the Crisis of Mathematics and Science Education in Indiana Elementary and Secondary Schools



Report of the Conference
Sponsored by
The College of Arts and Sciences
and
The School of Education
Indiana University
Bloomington, Indiana
October 19, 1982

On October 19, 1982, more than 300 persons from throughout Indiana met on the Bloomington campus of Indiana University to discuss a crisis facing the state: the decline of mathematics and science education in the elementary and secondary schools.

Participants at this conference came from a variety of occupations. Business, industry and labor leaders were there. Representatives from Indiana's legislative and executive branches participated. Scientists from Indiana's industries and research institutions were there, as were science, mathematics and education professors from more than 23 colleges and universities. Teachers and administrators from many of the state's school systems also participated.

All of the participants agreed that the decline of mathematics and science education is a crisis affecting everyone in the state, but this was not just a convention to recognize that a problem exists. It was a working conference to determine possible solutions to this problem, solutions that would work for Indiana.

Because the problem affects all sectors of society, a concerted effort by all sectors is needed for a solution. Business and industry must combine with government and education to combat the deterioration of science and mathematics education in Indiana. The participants at this conference stressed this need for cooperation and discussed a number of ways in which the separate sectors could work together.

The conference was organized into four panels to ensure generating specific inputs from each sector. Leaders from business, industry and labor comprised the first panel and reported on the specific effects this crisis has on the state's economy and how they are dealing with the problem. The second panel included leaders from Indiana's government who discussed the initiatives that could come from that sector and the problems they face in taking action against the crisis.

The third panel included teachers and school administrators from the state. Because any action taken to improve the quality of mathematics and science education will necessarily involve the state's educators, these panelists emphasized ways in which Indiana's educators could be helped in their efforts to teach the state's youth, as well as ways in which more qualified teachers could be attracted into the profession.

The fourth and last panel included representatives from the state's universities and technical colleges. It is these institutions that supply many of the skilled workers for the state and almost all of the state's teachers. If Indiana is to ensure enough skilled workers and qualified mathematics and science teachers to meet its needs, then these institutions must be helped in their work.

This conference was only the first step in dealing with the crisis. Awareness of the problem was increased and possible actions were proposed. But any real solutions to the crisis will require the continued efforts of all involved. It is hoped that strong and effective actions be taken soon, and that all sectors of Indiana will work together until the problem is solved.

Impetus for this conference came from a committee of educators at Indiana University who are greatly concerned about the decline of mathematics and science education in Indiana. The conference was organized by this committee and sponsored by the College of Arts and Sciences and the School of Education at Indiana University and was funded by the Lilly Endowment, Inc., and the Indiana University Foundation. Publication of this report was made possible through the generous support of the Delco Electronics Division of General Motors Corporation.

Facing the Crisis of Mathematics and Science Education in Indiana Elementary and Secondary Schools

Business, Industry and Labor Perspectives on the Crisis

- Bert Curry, Executive Director of Personnel, Eli Lilly and Company
- John Walls, President, Indiana State Chamber of Commerce
- Max Wright, Secretary Treasurer, Indiana State AFL/CIO
- Frank Jaumot, Director of Advanced Engineering, Delco Electronics Division, GMC
- Carole Gerstang, Vice President, Indianapolis Chamber of Commerce

Government Perspectives on the Crisis

- John M. Mutz, Lieutenant Governor, State of Indiana
- Marilyn Schultz, Member, House of Representatives, Indiana General Assembly
- Harold Negley, State Superintendent of Public Instruction

Public Schools Perspectives on the Crisis

- Cordell Affeldt, President, Indiana State Teachers Association
- Alfred L. Bias, Principal, Elkhart Central High School
- William Lumbley, Chemistry Teacher, Bloomington High School South

Higher Education Perspectives on the Crisis

- Allen H. Clark, Dean, School of Science, Purdue University
- H. Victor Baldi, Vice President, Indiana Vocational and Technical College
- F. Keith Ault, Professor of Chemistry, Ball State University

Summary and Recommendations

Introductory Remarks

George Springer, professor of mathematics, Indiana University

Because Indiana's economy has been closely linked to the production of automobiles and steel, this state has been one of the hardest hit by the current economic malaise. There has been a general recognition in the state of the need to compete with the other 49 states for new industries to shore up our economy and provide new employment opportunities. But the same needs have been recognized in every other state, and the competition will be fierce.

In selecting sites for locating business or industry, the available work force is an essential factor, and the new high-technology industries require both better trained and better educated personnel. Richard Stoner, vice chairman of the Board of Directors of Cummins Engine Company, has written that "Educational climate is the number one factor Cummins considers in locating new plants. This has been confirmed repeatedly by people seeking new industries for Indiana."

What is Indiana doing to prepare its children for the new work force that requires some level of scientific literacy and mathematical skill for almost all of its employees?

While Indiana had 2.38% of the total U.S. population in 1979, it had only 1.68% of the U.S. citizens who had completed four years of college—the lowest percentage of the 15 largest states in the nation and well below the national average.

Indiana has three persons with less than four years of high school for every person with four or more years of college. Compare our statistics with those for states such as Illinois or Missouri which have two people with less than four years of high school for every person with four or more years of college, or to those for states such as California and Massachusetts which have one person with less than four years of high school for every person with four or more years of college.

Sputnik shook everybody up because it was something our enemies did that we could see. But this is a quiet crisis and a lot of people don't believe in it. They need to be informed.—*Robert Jentgens, Crane Naval Weapons Station*

In the past, students easily succumbed to the temptation to drop out of high school and take jobs as unskilled laborers. We must now convince students to stay in school and train for the more demanding jobs that may be the only ones available for them when they enter the job market.

Are students responding to the demands of the job market? Data indicate that fewer Indiana students are now studying mathematics and science beyond ninth grade than a decade ago. There has even been an 18% decline since 1972 in the number of students taking algebra (compared to an 11% decline in total enrollment in Indiana public secondary schools during the same period), and we must remember that algebra is the key subject for further study in mathematics or science.

And how are we showing our determination to improve our educational programs? We allow ourselves to rank 34th in the nation and last among Midwestern states in terms of per pupil expenditures for education!

At the same time that the state is facing a need for a population that is better educated in science and mathematics, it is facing a critical shortage of secondary school mathematics and physics teachers and a shortage of chemistry, earth science and general science teachers. In 1982, Indiana's four major state universities graduated only enough mathematics teachers to fill 58% of the teaching vacancies. Even more shocking are statistics indicating that in 1982 these same four universities graduated a total of 3 chemistry students, 4 earth science students, 4 general science students, and 2 physics students with qualifaications to teach in these areas. Moreover, several (if not all) of these graduates probably chose not to take teaching positions because of the inability of school systems to offer salaries anywhere nearly competitive with those that business and industry can offer to people with their training in science or mathematics.

The states and the private sector must now assume a greater role in seeking ways of improving education. We have convened this conference to provide a forum for the three major constituencies—the private sector, state government, and the educational sector—to give their perspectives of the problem and propose ways that each can act, individually or cooperatively, to provide the improved educational climate Indiana needs so badly. Too much is at stake in this effort to even contemplate failure.

Business, Industry, and Labor Perspectives on the Crisis

Education has become an economic necessity, and many recent reports have emphasized that the economic structure of a community depends on its investment in education. As states increasingly compete for new businesses, especially high-technology industries, the availability of a well-educated work force has become a crucial factor for economic survival.

Bert Curry, the executive director of personnel operations for Eli Lilly and Company, explained that his company relies heavily on Indiana's schools to provide the workers Lilly needs. Out of about 3,300 persons working for Lilly in research and development activities, two-thirds are technicians who do not hold degrees, Curry said. Therefore, Lilly encourages prospective employees to take as much high school mathematics and science as possible.

The day is past when parents could say to their child, 'just get your diploma and everything will be all right.' —*Max Wright*

John Walls, president of the Indiana State Chamber of Commerce, suggested that there are three options available for alleviating the shortage of qualified mathematics and science teachers. These include doing nothing, which Indiana simply can not afford; paying all teachers more, which is economically impossible; and finding a way to pay teachers in heavy demand areas more than those in areas of oversupply. The third option, Walls argued, is the only one feasible.

Indiana's unions are also greatly concerned about the quality of mathematics and science education because there is no longer a need for workers who do not understand mathematics and science, *Max Wright*, secretary treasurer of the Indiana AFL/CIO, explained. He added that in union apprenticeship programs for construction workers, machinists and other occupations, a good understanding of mathematics and science is essential.

The AFL/CIO therefore has a number of recommendations for improving mathematics and science education, Wright said. These include (1) encouraging students with talent in mathematics and science to continue studying these subjects beyond high school, (2) making school counselors more aware of job opportunities and their mathematics and science requirements, (3) setting up scholarship funds to encourage students talented in mathematics and science, (4) bringing teacher salaries more into line with salaries for other professions, and (5) making funds available for continuing education for teachers to help keep them up-to-date.

"The current and growing shortage of math and science teachers, and particularly good ones, is occuring for the same reasons that students are not taking math or science: lack of incentives," *Dr. Frank Jaumot*, the director of advanced engineering for the Delco Electronics Division of GMC, argued.

"In industry we know that both the price and volume of a product are determined by the marketplace if one wants to compete," Jaumot said. "If it means paying science and math teachers more, whether directly or indirectly, so be it. If it means providing them with better equipment than the home economics teacher, so be it."

Jaumot argued that Indiana should concentrate the training of mathematics and science teachers in a very limited number of institutions and also require that teachers take a reasonable amount of continuing education. He also said that more units of mathematics and science should be required for students, even at the expense of units on sex education, drugs and alcohol, nutrition and energy conservation.

Carole Gerstang, vice president for the Indianapolis Chamber of Commerce, emphasized that partnerships linking business, industry and the schools are necessary both for raising students' aspirations and interest levels in mathematics and science, and for raising teachers' awareness of the use of mathematics and science in the real world.

All the panelists agreed that the economic well-being of the state depends on the well-being of our schools. Several of the panelists suggested that differential pay for mathematics and science teachers may be desirable but, by itself, will not solve the problem. Other incentives are needed as well. All the panelists agreed that a closer alliance between business, industry and the schools is necessary.

Government Perspectives on the Crisis

The need for the state government to be involved in any effort to improve mathematics and science education in Indiana's elementary and secondary schools should be obvious. The state is responsible for providing funds to operate the schools, for licensing the teachers and for establishing the minimum requirements for graduation.

Indiana Lt. Gov. John Mutz said that the state needs to spend more money for education, although the governor's policy for the past two years has been not to raise taxes despite increasing requests for money from the state's school corporations.

"The kind of commitment government needs to make is the one that reflects the importance of education in the future," he said. "Additional investments in the future of this state are essential."

If we could get our superintendents and principals to put as much effort into finding qualified math and science teachers as they put into finding coaches, I think we would have part of our problem solved.—*Marilyn Schultz*

Mutz, who is also director of the State Department of Commerce, explained that available jobs, and the kind of training that will be required for these jobs, are likely to change dramatically in the next 10 to 15 years.

"The economic analysis section of our department is determining what we call 'the targeted industries' for the future in Indiana. They are significant in terms of why mathematics and science, foreign language, and computer literacy and those related subjects are important areas for concern in terms of our educational system," Mutz said. He explained that these targeted industries are the communications/electronics industry; the diesel engine industry; the materials industry, including the production of steel and aluminum; and the energy industry, all of which will require a work force knowledgeable in mathematics and science. He added that even the agricultural industry, with the use of the new recombinant DNA technology, will require a highly skilled work force.

Marilyn Schultz, the state representative from Bloomington, agreed that Indiana needs more money for basic education programs in the elementary and secondary schools, as well as a substantial investment in equipment, including computers, for the schools. But money is just the starting point, she said. Some of the options Schultz suggested for recruiting more mathematics and science teachers were forgiving student loans for those entering teaching in critical shortage areas, state-funded retraining of teachers, putting emphasis on part-time teaching to allow graduate students and retired scientists to teach, state-supported summer programs for students and teachers, offering teachers summer jobs with business and industry, and giving teachers more career opportunities by offering them 12-month contracts.

Schultz, who is a member of the Governor's Select Commission on Primary and Secondary Education, also said that stress and criticism should be applied to school administrators who allow and foster unqualified personnel in the classrooms.

"I have heard case after case of qualified science and math teachers waiting to fill a vacancy until after the coaching position was filled, because the highest priority in that high school or middle school was getting a football coach who could if necessary teach math, whether or not qualified, rather than getting that math teacher in," Schultz said.

But as bad as the teacher shortage is, the shortage should be even greater, *Harold Negley*, the state superintendent of public instruction, explained.

"The real shortage is that there wasn't a group of youngsters out there who were pressing, and whose counselors were pressing them, to cause a shortage of teachers," Negley said. He added that if students were taking as much mathematics and science as they need, the teacher shortage would be much greater than it currently is.

Negley pointed out that a grassroots movement for more science and math education has begun, but that more leadership from school administrators is necessary. He added that the Commission onGeneral Education, which he chairs, will be pushing to raise the minimum requirements for mathematics and science in the schools.

Public Schools Perspectives on the Crisis

Whatever initiatives are eventually taken to solve the problems in mathematics and science education, Indiana's teachers will be a central factor for their success. But the supply of teachers is dwindling steadily. In Indiana, only about one-third as many persons entered teaching last year as a decade ago. Furthermore, 10% of the teachers under 40 years old recently responded to an Indiana State Teachers Association poll by saying they definitely plan to quit teaching as soon as possible, and another 62% said they plan to leave but either had not decided when or were waiting for something better to come along. Clearly, if a solution to the problems of mathematics and science education is to be found, then teachers' concerns must be taken into account.

Cordell Affeldt, the president of the Indiana State Teachers Association and an elementary school teacher, emphasized that problems causing the shortage of mathematics and science teachers are also causing shortages of teachers in many other areas. Furthermore, these problems are likely to become much worse in the next decade, Affeldt said, adding that the use of quick fixes, such as "bounty pay" (paying higher salaries to teachers of particular subjects) and the use of unqualified personnel in the classroom, is simply shortsighted and will not solve the basic problem.

In education, it seems at times that it is forgotten that our final 'product' is a vital piece of humanity.—*William Lumbley*

William Lumbley, a chemistry teacher at Bloomington High School South, agreed that the salaries of science and mathematics teachers should not be raised above those of other teachers. While inadequate salaries are a malignancy that continues to drive teachers from the profession, Lumbley pointed out that there are many other problems affecting teachers. He added that because of these problems, he can not counsel a talented student to enter teaching.

"I could not, in good conscience, try to convince them to enter a field where the pay is half of what they could receive in the private sector with the same background, where the pressures of 'accountability' are not based upon what you do and how well you do it but rather on hearsay and personality conflict, where your product is never publicized and seldom returns to say 'Thank you,' or where the hours that are necessary to adequately prepare for the next day detract from the care and attention of your own family members and their needs," Lumbley explained.

Lumbley stated that the conditions under which mathematics and science teachers work must be improved. Some of Lumbley's recommendations include "that no science laboratory course be conducted with more students enrolled than there are safe, functioning laboratory stations available that the science teacher be given the same consideration in time and budget for preparing and maintaining curricular activities as others are for extracurricular activities," and "that active support and observational basis for that support create an awareness in the decision makers, the policy formulators and the general public that the work of the science teacher is not simply an amoeboid motion nor a puff of smoke."

Alfred L. Bias, the principal of Elkhart Central High School, agreed that salaries and working conditions must be improved, and added that the image of teaching as a career should also be promoted both in the schools and universities and among the general public. "Teachers want to be appropriately paid and appropriately respected," Bias said.

There are pressures now at work that are likely to intensify all shortages in the future.—*Cordell Affeldt*

All of the panelists agreed that the problems affecting mathematics and science teachers also affect all teachers. They emphasized that a commitment to quality education from the state is desperately needed, not only in terms of higher salaries but also for regular, funded inservice training and continuing education for teachers. They also suggested that teacher/professor exchanges, summer employment programs for teachers in business and industry, and forgiveable loans for education students be established as soon as possible.

Higher Education Perspectives on the Crisis

They find a warm body to slip into a classroom somewhere and turn off the kids, which is virtually what happens from day one.—*F. Keith Ault*

One of the major resources available for combating the crisis in mathematics and science education is the state's universities and technical colleges. It is in these institutions that Indiana's teachers and skilled workers are trained. These institutions also hold a large pool of scientists and educators who can be tapped to help retrain teachers that are already in the classrooms, as well as providing the expertise needed to design the programs and curricula that will be needed if the crisis is to be solved.

"I think we have come to the time where we must look for a revision of the state tax structure," *Allen H. Clark*, the dean of the School of Science at Purdue University, told the conference participants. "The property tax freeze, the fact that we are very low in income tax and in sales tax, simply means that we do not have the resources to do what needs to be done and to make the improvements that need to be done."

Because Indiana's teacher shortages are severe, the state needs to move faster than other states to solve the problem, Clark said. Incentives for elementary and secondary school teachers should be increased, and the National Science Foundation Summer Institutes for teachers, which ended eight years ago in the summer of 1974, should be reinstituted, he added.

Clark recommended that national standards should be set for elementary and secondary school curricula in mathematics and science: "Not accreditation, not a huge system of boards investigating school districts, but publish what the curriculum should be and how many years of chemistry, physics and mathematics students should have to prepare for various college opportunities."

H. Victor Baldi, vice president of Indiana Vocational and Technical College, said that many high school graduates have insufficient backgrounds in mathematics to be successful in post secondary education, including vocational training. Because of this, IVTC and other two-year institutions have to place tremendous emphasis on remediation and developmental studies.

Money will not solve all the problems . . . but certainly, this is one problem that wouldn't be hurt by having some money thrown at it.—*Allen H. Clark*

"Before the student can get down to the business of studying whatever he or she came to study, there has to be some effort to provide them with the basic skills to be successful enough in a particular program," Bladi explained, adding that the inability to handle mathematics is one of the major reasons why students drop out of their courses.

Baldi said that mathematics is particularly important because all courses require mathematics skills. He gave as an example a recent state-wide curriculum meeting concerning their welding program. Baldi said that welding instructors wanted two math courses for their students but he thought that one would be enough: "because, after all, it's just a welding course. Until the welders told me, 'Well, all right. We'll go for one math course provided you get the trig functions in the first mathematics course.'"

Many Indiana colleges have to focus on remedial education to supply skills that should have been learned in high school, Baldi said. "I do not think that there is a sufficient amount of math, or science, or a few other meaningful subjects being required of students. In fact, the graduation requirements seem to have reduced themselves to a minimum common denominator approach which, in my opinion, can only lead to mediocrity."

F. Keith Ault, a professor of chemistry at Ball State University, agreed that students are not learning enough mathematics and science, and suggested that part of the problem is the public's perception of the importance of these subjects.

"There is a school corporation within 20 miles of Muncie. I won't mention the name, but that school corporation two years ago had $75 for a science budget that was to be used by more than 300 students. That kind of effort on the part of the school administration is insidious," Ault said.

All of the panelists agreed that the state must increase funding for the schools if quality education is to be provided. It was repeatedly pointed out that Indiana must *at least* bring the funding for its educational institutions up to the national average.

Summary and Recommendations

The last segment of this conference on the crisis in mathematics and science education in Indiana's elementary and secondary schools included a discussion by all of those participating in the conference on recommendations for a solution. All of the participants had a chance to voice their opinions on each recommendation, and after much discussion the following recommendations were agreed on. These recommendations have been organized into categories based on where initiatives for action would originate.

Recommendations for State Government

1. The State Department of Public Instruction should establish a policy that all high school graduates will have studied mathematics and science for at least three years in grades 9-12. Students preparing to attend college should be urged to study four years of mathematics and science.

2. A program of "forgiveable" loans to college students preparing to teach mathematics or science should be established.

3. The governor should establish a commission on precollege mathematics and science composed of representatives from each of the four sectors represented at the conference.

4. A policy should be implemented that will ensure that elementary and middle/junior high school teachers are adequately prepared to teach mathematics and science.

5. State agencies should work with colleges and universities to identify ways to attract women and minorities into mathematics and science careers.

6. The state should support in-service institutes (especially summer institutes) for the continuing education of mathematics and science teachers. Such institutes should be funded jointly by support from state agencies and the private sector.

7. The state should begin a program to train retired persons with strong mathematics and science backgrounds who might be interested in part-time mathematics or science teaching.

8. The state should establish statewide educational goals and public policies for mathematics and science education, or at least support the development of an agenda for action in attacking the problem.

Recommendations for School Systems

1. Both mathematics and science should be taught to all students during every year in grades K-8. School systems could hire mathematics and science consultants and resource teachers for the elementary grades to facilitate this.

2. School systems should hire only qualified teachers to teach mathematics and science in grades 6-12.

3. School systems should give priority in hiring teachers to applicants with relatively strong mathematics and science backgrounds, particularly elementary school applicants.

4. School systems should establish a policy of professional development incentives for teachers in critical shortage areas.

5. School systems should require all students to study about computers to the extent necessary to ensure computer literacy.

Recommendations for Colleges/Universities

1. College/university teacher educators should evaluate their mathematics and science teacher education programs with the goal of determining how to make them more attractive to prospective teachers and more relevant to the needs of practicing teachers.

2. College/university faculty should be more willing to go to schools as resource persons.

A lot of people out there think their kids are getting a good education, that they are getting everything they need. They badly need to be informed.—*Robert Jentgens, Crane Naval Weapons Station*

3. Colleges/universities that have summer institutes for talented mathematics and science students should hire selected high school teachers as adjunct faculty for these institutes.

4. College/university mathematics and science educators should find more ways to utilize computers as instructional devices in mathematics and science classrooms at all levels. They should also establish workshops for developing computer literacy.

5. Colleges/universities should raise their entrance requirements in mathematics and science.

6. Colleges/universities should actively recruit women and minorities into mathematics and science careers.

7. Colleges/universities should develop adult education programs in mathematics, science and computers.

8. College/university mathematics and science students should be encouraged to volunteer as part-time teachers in schools where mathematics and science teachers are needed. They should also serve as resource persons in elementary schools.

Recommendations for the Private Sector

1. Businesses/industries should provide part-time and summer employment for mathematics and science teachers.

2. Businesses/industries should assist state and local governments in providing low interest loans to students who are preparing for teaching careers in mathematics and science.

3. Businesses/industries should use their facilities for the development and recognition of teachers.

4. Businesses/industries should devise means to allow employees with strong mathematics and science backgrounds to teach mathematics or science part time in schools.

5. Businesses/industries should make available to schools and colleges information about career opportunities in mathematics and science-related areas.

6. Businesses/industries should help support the training of retired persons with strong mathematics and science backgrounds who might be interested in part-time mathematics or science teaching in the schools.

General Recommendations

If a coach loses a star player, that's news. If a teacher loses an entire program . . . that's too bad.—*William Lumbley*

1. The four sectors should work together to establish some consensus about the mathematical and scientific knowledge *all* students should acquire, both for high school graduation and college admission.

2. There should be a cooperative effort among the four sectors to determine attractive opportunities for continuing in-service education for mathematics and science teachers.

3. The four sectors should establish more mathematics and science teacher resource centers around the state.

4. The four sectors should work together to identify means for recognizing and rewarding outstanding performance both by teachers and students at every level.

5. All sectors should provide incentives to raise the prestige of mathematics and science teaching as a profession.

6. Government agencies, schools and colleges/universities should cooperate to retrain surplus teachers who have some aptitude, interest and background in mathematics or science. This would help alleviate the shortage of mathematics and science teachers.

7. Action needs to be taken to convince the public that improvements are necessary.

It is hoped that action will soon be taken on these recommendations, and that the current crisis in mathematics and science education in Indiana's elementary and secondary schools will be solved. The most important resource our nation has is its youth, and we are jeopardizing our future by neglecting our next generation.

○